# Light and Lighting

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## Contents



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# School Lighting

WITH this first number of our forty-fourth volume we commence a series of articles dealing with the important subject of school lighting. The role of seeing in learning is paramount for most of us, and we bear witness to this in our use of visual terms to express our comprehension, or otherwise, of instruction received even through other avenues than the eyes. " I see " is a common substitute for " I understand," and " I don't see why " for " I don't understand," and these colloquialisms ought, as often as we use them, to remind us how potent is the educative power of sight. In schools and colleges the eyes should be allowed to function easily and efficiently, and for this sufficient and suitable lighting is a *sine qua non*. Our knowledge of what is sufficient and suitable is in advance of our practice in schools generally, but it is encouraging that reasonable standards of natural and artificial lighting are now prescribed by the Ministry of Education and are being implemented in new schools.

# Notes and News

## *Lighting in Schools*

With this issue we publish the first of a series of articles on the lighting of schools. We feel quite strongly that this is a subject that has not been given the attention it deserves, though we appreciate that, where new buildings are concerned, the question of good lighting is now considered far more carefully than it was at one time. But, just to show that we are not concerned only with new schools, we start this series with an article from one who knows just how bad conditions can be—a schoolmaster. Such an author can have no axe to grind in stating a case for better lighting.

From this review of existing conditions we will in future articles deal with the visual task in the school-room, recent research in school lighting, and the architect's viewpoint of the lighting problem. The series will also include details of some of the most recent school lighting installations both in this country and abroad.

## *Brightness Engineering*

We note that the subject of the January meeting of the I.E.S. in London is that of Brightness Engineering. We believe that this is the first time this subject has been formally discussed in this country, though most lighting engineers are aware of the attention which has been given to it in the United States. The paper by Mr. W. Robinson is a review of progress made during recent years.

The subject is one which should attract a good audience, for there is no doubt that most lighting engineers are aware of their ignorance of this subject and are anxious that this should be remedied as soon as possible. Most of the work reviewed will no doubt have originated in the United States, though the work of Hopkinson and Petherbridge will surely be included. Incidentally, without reading their paper again we have a feeling that Hopkinson and Petherbridge have carefully avoided the use of the term "brightness engineering"; perhaps they object to it for some reason or other. We ourselves must admit that we find it rather clumsy and incongruous that the chase for an abstract brightness should be called engineering. It will be recalled that there have been many attempts to derive a new term for illuminating engineering, but there is much more justification for this later term than there is for brightness engineering.

However, the main controversy does not rage around the name we have given this business, but is far more concerned with the permissible range of brightnesses in the field of vision and on how the lighting engineer can make use of these new techniques in his everyday tasks. Perhaps Mr. Robinson's paper and the

### *Trotter-Paterson Memorial Lecture*

**The first Trotter-Paterson Memorial Lecture will be given at the Royal Institution, Albemarle-street, London, W.1, at 6 p.m. on Wednesday, January 17. The lecture will be given by Dr. J. W. T. Walsh, who will speak on the subject "The Early Years of Illuminating Engineering in Great Britain."**

**Admission to the lecture will be by ticket only, and tickets may be obtained on application to the Secretary, the I.E.S., 32, Victoria-street, London, S.W.1.**

following discussion will clarify some of these points.

The paper is to be presented on Tuesday, January 9, at 6 p.m., at the Lighting Service Bureau, 2, Savoy-hill, W.C.2, and we are asked to invite all those interested in the subject to be present.

## *Subjective Judgments*

A conference on Subjective Judgments was held at University College, London, a short while ago, at which several matters of interest to lighting engineers were discussed. The conference, which was arranged as a private venture by a small committee, with Dr. R. G. Hopkinson as secretary, was intended to bring together physicists, engineers, and psychologists who are working on problems which involve "man as a measure of his surroundings."

Subjective studies have made considerable headway recently as the result of the more widespread use of statistical methods of analysing data. Such methods not only enable the results of subjective judgments to be interpreted with greater certainty, but properly applied they can also assist in the design of the experiment, before results have been obtained. The value of well-designed experiments was stressed during the conference.

The first session was devoted to the problem of the relationship between the physical stimulus (for example, *luminance*) and the resultant sensation (*brightness*, or *luminosity*). Doubts as to whether sensations could or could not be measured seemed to turn on matters of interpretation. Prof. Oldfield (Reading University) suggested that it would be fruitless to search for a direct relationship in terms of simple duality, but that some useful form of relationship could be assumed to exist; for example, the logarithmic Weber-Fechner Law of contrast. Prof. Pickford (Glasgow University) summed up the position by suggesting that, even if sensations could not be measured, it was often possible to proceed usefully as if they could, and he counted himself among the "as ifs."

The afternoon session was devoted to consideration of the usefulness of the human being as an assessor of his surroundings. The techniques used for subjective assessments in acoustics (Mr. Richards, Post Office Engineering Research Station) in tactile studies (Dr. R. Harper, University of Leeds), in lighting (Dr. Hopkinson, D.S.I.R., Building Research Station), and in taste (Dr. Bate-Smith and Dr. Ehrenberg, D.S.I.R., Low Temperature Research Station and University of Cambridge) were outlined and discussed. The subsequent discussion was lively and informative, and the practical aspect of the problem was always prominent. As Dr. Bate-Smith pointed out, the conference divided itself into the "can'ts," who were to the fore in pointing out the fallacies of some of the experimental methods, and the "musts," who insisted that, however philosophically unsound their techniques might be, they served their purpose if they gave data of precise engineering value. A topic which raised much discussion was the use of "trained observers" for subjective studies. Such subjects can give assessments readily, and can repeat their readings with reliability. Their observations can be demonstrated to agree at selected points with those of the "mob," and it can therefore be argued that to employ a few such observers yields the correct values more quickly and more reliably. Many speakers felt that this was a dangerous procedure, however. Here again the "musts" pointed out that if they had to employ, say, 500 observers for every experiment, little or no progress in the work would be made.

The interest shown demonstrated that the time is ripe for some systematisation of the techniques of subjective studies, but it is evident that it will have to be done by the "as ifs" and the "musts." The assistance of the others will await the time when, as Mr. Babington-Smith (University of Oxford) pointed out, the extra-sensory processes have been studied in greater detail and have revealed some of their secrets.

*Seasonal sign in London is this illuminated Christmas tree, which has been set up in Trafalgar Square.*

# A Review of Lighting Conditions in Schools

**This article is the first in a series on school lighting. The series is designed to show the need for a higher standard of lighting in schools and to bring about a better understanding of the problem involved and thereby closer co-operation between the educational authorities, the architect, and the lighting engineer.**

Contributed by a schoolmaster

### Influence of Architecture

Many of the primary schools in this country are more than 40 years old, and in these the standard of lighting, both natural and artificial, is often seen at its worst. School architects of Victorian and Edwardian days often paid scant attention to the interior lighting of the buildings they designed. It is possible that in those days, as schools were not normally occupied during the evenings, it was considered unnecessary to provide them with more than the barest, and cheapest, minimum of artificial lighting, to be used for short periods in the late afternoon of winter days. This overlooked entirely the effect of heavy clouds on a stormy day, even in summer, when the light has to be switched on to supplement the entirely inadequate daylight. Many schools, too, in urban districts are now used for evening classes attended by young people who have recently left school and are taking preliminary courses to qualify them for entry to a senior technical institute. It is very depressing for such young people, tired after a day's work, to have to come to a drab, ill-lit class-room, and small wonder that many turn instead to the gaily lit centres of commercial entertainment in the towns.

In many older schools the windows have many small panes of glass and are placed high up in the walls of the class-rooms, or the clear glass in the upper panes gives way to frosted glass in the lower part of the window, with a consequent diminution in the amount of light entering the room. A considerable number of schools, both privately and publicly owned, use buildings which have been converted from dwelling-houses with little or no structural alteration. Pressure on space in such buildings has resulted in quite large classes of children being taught in form-rooms on upper floors where the ceilings slope and the windows, being placed low down, give little or no top-light at all.

The amount of light falling on a particular desk must depend to a large extent on whether direct light from the sky is reaching it. With windows placed low down on the walls, the desks remote from the window will receive little direct light at all, and, especially in urban districts, the only light will be that reflected from the often dark buildings outside. Rooms with small-paned windows set high up admit more direct light from the sky, but much of this is intercepted by the bars between the panes. It is quite an interesting, if not illuminating, problem in mensuration to get pupils to calculate what percentage of the window area is obstructed in this way.

A child whose desk is placed close against the wall beneath a window which is high up in the wall is probably worse off for illumination than one whose desk is a few feet nearer the centre of the room, where it gets direct light from the sky. Children soon realise which are the best-lit desks, and although shadows may appear to offer advantages to those who have surreptitious activities to conceal, it is significant how many pupils will arrive early on the first

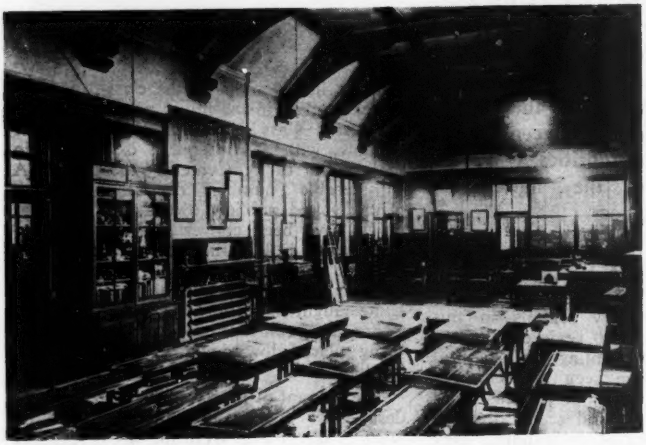
day of a new term to try to secure the best-lit places.

### Effects of Poor Lighting

It is generally agreed that poor lighting has an adverse effect on the quality of work done by adults, and it is noteworthy that during the war, when every effort was being made to step-up production and increase the output per man-hour, special attention was paid to the lighting of new factories, and vast numbers of fluorescent and other lamps were installed to brighten the interiors to a degree seldom met with in pre-war days. It might be thought, therefore, that more attention should be paid to brightening the interiors of class-rooms where children are working. It must be remembered that children have not developed those powers of concentration which may be used by an adult to offset poor working conditions, and it may be just as hard for a child to work out a problem in geometry in his exercise-book as it is for an adult draughtsman to design a machine tool. Yet how different may be the conditions in which they work!

If the draughtsman finds the daylight inadequate he can usually switch on some excellent general lighting, often from rows of fluorescent tubes, which casts no shadows on his drawing board. Sometimes this is supplemented by a strip-light fixed along the top of the board. Yet little Tommy Smith, doing, for him, an equally difficult and exacting job, has no such lighting to help him. As he draws a pencil along his ruler's edge, in an endeavour to construct a passable triangle, he finds that the light filtering through to his corner from the grey buildings across the road is inadequate to show up clearly the divisions on the scale. After straining his eyes vainly to see whether the line is the correct length he may have the light switched on to help him.

These lights will commonly be four naked bulbs dangling from flexes beneath a not-too-clean ceiling. Sometimes, as a concession to the amenities of the room, the bulbs are surmounted by shallow conical glass reflectors which do little to control the distribution of the light and, when broken, are seldom replaced. The bulbs will probably be of 60-watt rating, but here and there a 40-watt lamp may have been used as a replacement. Clear and pearl lamps may appear in equal numbers.



Showing a classroom with nearly every lighting fault; the windows are too low for the size of the room; gloomy ceiling and dark paintwork; unenclosed lamps give direct glare and glare from the shiny desks.

Such lighting provides Tommy with a new set of problems. He gets more light on his book, but, as he bends forward, the shadow of his head falls across the page and obscures his ruler more deeply than before. He bends his head to one side to clear this shadow, but he is still bothered by the shadow of his hand across the scale and the accuracy of his work suffers. In certain parts of the room, if the paper is glossy, an angry spot of light will be reflected obstinately from it into his eyes. He may get used to this and eventually think nothing of it, but it is there all the time, a glaring spot worrying at the nerves in his eyes.

This type of lighting also raises difficulties for the teacher. The only blackboard pro-

vided is probably one placed on an easel or one with boards pivoted at the centre to make it easily reversible. Both types of blackboard have to be moved about in the room to some extent as they may occupy space which has to be used at other times for certain activities. When the lights are switched on it is almost inevitable that a concentrated beam of light from the nearest lamp will be reflected from the shiny surface of the blackboard straight into the eyes of one or more members of the class. This beam prevents the children concerned from seeing what is written on that part of the blackboard from which it is reflected, and these children will soon complain to the teacher. If the teacher endeavours to improve matters by adjusting the angle or position of the board, he will only reflect the beam to another part of the room, probably into someone else's eyes. Much time may be lost at the start of every lesson requiring use of the blackboard before a satisfactory position for it is found, and even then some children may have to crane their necks to one side to see what is written on one part of the board.

Vertical blackboards fixed to the wall do not appear to have these bright spots to the same extent, as the light is not reflected at a troublesome angle. It is not possible, however, in some class-rooms to find room for these boards, and the portable type will continue to be used in large numbers. The fixed wall-blackboards can be very well illuminated by a directional type of fitting mounted at a suitable angle on the ceiling, and in rooms where this is done a great improvement is noticeable. One case, at least, is known of a fluorescent tube with suitable reflector being mounted close to and slightly above the blackboard with the fitting tilted to spread the light more uniformly over it.

Good diffused general lighting would appear necessary for satisfactory illumination of movable blackboards, though this does not give that extra light on the board which is so useful for focusing attention upon it. This focusing of attention is a considerable help in teaching.

### Switching Arrangements

In the interests of economy more attention should be paid to the grouping of the lights controlled by one switch. With the common arrangement of windows down one side of the class-room and four lights arranged in square or rectangular formation, the obvious way of grouping the lights is to arrange them in pairs so that the darker half of the room can be lit first as daylight fades. Yet how rarely is this done! When two switches are provided it seems the rule rather than the exception for the pairs of lamps controlled by each switch to be one on the bright and one on the dark side of the room. It is then necessary to switch on all four lights at once, although the two nearest the window may not really be required. The responsibility for such switching may lie with the electrical contractor who did the wiring. Possibly it was slightly cheaper in first cost that way, though an inspection of the conduit runs, when visible, often shows that there could really have been little difference in price between the two ways.

### Secondary Schools

Until a great deal more school building is done, much secondary modern education is being provided by the higher classes in primary school buildings. The buildings of the better, self-contained secondary modern schools are in many cases of fairly recent design and were formerly called selective central schools. In these the lighting, both natural and artificial, is quite good, though in the interests of economy the latter may fall short of the best standards.

Secondary grammar schools owned by local authorities and independent public schools are often the show places of the educational world and are housed in buildings which may have some considerable architectural merit of an ecclesiastical kind. The beauty of grey stone and mullioned windows has, however, to be set off against the comparative obscurity of many of the rooms within. It is fortunate that when new blocks are added to such schools the modern tendency is to design them with really good natural lighting, with no attempt to reproduce the dimness of the rooms in the old buildings. The artificial lighting provided is often on a more generous scale than in primary schools and the lamps are placed inside reflectors or globes. Many reflectors still in use, however, are of an inefficient or unsuitable type.

Secondary schools usually have a fairly large assembly hall, with a platform at one end, which is used for morning prayers, lectures, concerts, etc. This is frequently hemmed in on all sides by classrooms so that the only natural lighting comes from windows, sometimes of stained glass, placed high up at the ends of the hall, and perhaps above the classrooms along the sides. This may be adequate for morning prayers and for lectures where little or no reading or written work is done by the children, but very often these halls are used for end-of-term examinations, because candidates can be well spaced out in them. This is one

of the occasions, above all, when really good artificial lighting is essential if daylight is not enough. The nervous strain of an examination should not be increased by the stress of trying to work in indifferent light. There would appear to be a case here for some selective switching whereby a much greater number of lamps than now provided is installed, but only alternate lamps switched on for the usual functions, the whole installation being used for examinations. A master switch is a great convenience for the rapid dimming of the hall for a film show or lantern lecture, but is seldom found.

### Colleges of Further Education

As a general rule the artificial lighting of technical and other colleges of further education is superior to that found in primary and secondary schools. This may be due, in part, to a recognition that a large proportion of the work in these colleges is done in the evenings. The principal may be an engineer or have members of his teaching or maintenance staff who are specially interested in lighting problems, and provided that the financial backing is available, a good lighting scheme can be worked out. In some of the newer colleges, or extensions to old ones, the lighting is particularly good, with fluorescent or cold-cathode lamps for drawing offices and enclosed diffusing fittings for general lighting.

In some of the older colleges the lighting, although good for the period in which it was installed, has become rather outdated and in need of replacement or overhaul. The cost of wholesale renewal is, however, very formidable and progress here may lie along the lines of using higher-powered lamps, suitably enclosed to avoid glare, and of gradually replacing the installation in certain selected rooms, especially drawing offices and other rooms where fine work is done.

### Cloakrooms

The usual tendency is to provide the barest minimum of lighting in cloakrooms and lavatories, but this may, in the long run, prove a false economy. Such rooms are not occupied continuously or for any great length of time during the day, so that the installation of higher-powered lamps should not increase appreciably the electricity consumption of the whole school. On the other hand, much time may be saved by better lighting. It is far easier for children to change their clothes, and especially to lace up their shoes, if they can see well; while lost or mislaid articles—a source of much wasted time and much exasperation in a school—are more easily found. Petty pilfering, though fortunately not common, is encouraged by dark corners. A well-lit room is a sure deterrent.

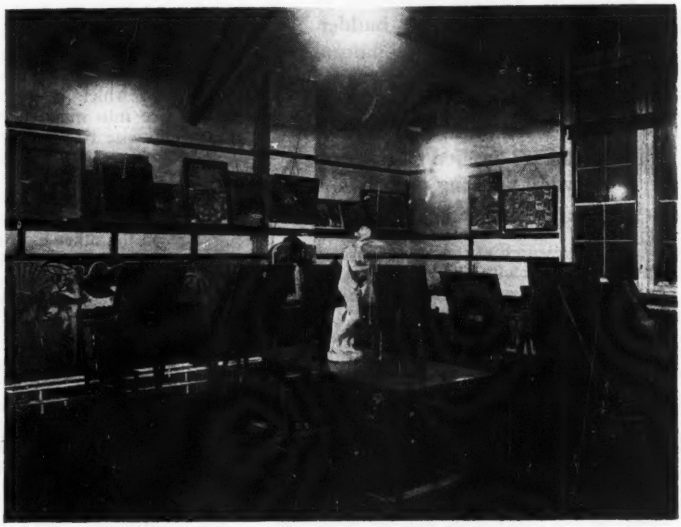
Small assembly hall surrounded by classrooms. Most of the seats receive neither adequate daylight nor artificial light.

### Lighting Control

At present the switching on of lights to meet variations in illumination during daylight hours is left to the discretion of the teacher, aided perhaps by some promptings from members of the class. This is not

altogether satisfactory, as the teacher may have his desk in a favourably situated part of the room and not realise the conditions in the far corner. Further, the human eye is not always a good judge of illumination when this is gradually weakened and does not always warn its owner that the room is becoming uncomfortably dark until the illumination has fallen well below the level normally regarded as the minimum for comfortable work.

If, as we believe, children's eyesight is something worth taking care of, a good case can be made out for the use of photoelectric cells for switching on the lights automatically as daylight fades. A cell and suitable relay placed in the darkest corner of each classroom could be used to switch on the lamps when the illumination fell to a pre-determined level, and a master switch could be operated at the end of the day to prevent any possibility of the lights coming on during the night.



Example of bad artificial lighting in an art room.

### Cost

As so many schools have inadequate or unsatisfactory lighting, the cost of replacement is bound to be considerable, and local education committees, with their eye on the next municipal elections, may well hesitate before approving expenditure which will increase the rates, in which the cost of education is already one of the largest items. The very heavy initial cost of fluorescent lighting can be justified only if it is used for very many hours during the year, when its running economy makes possible a favourable comparison with tungsten. As this condition does not generally apply to a school, it is in the direction of better lighting by higher-powered, better-diffused tungsten lamps that we must look in the immediate future.

It is difficult to estimate the effect of continued poor lighting on a child's eyesight. No parents would allow their child to participate in any long-term experiment in which one class in a well-lit room had its eyesight compared with that of a class in a badly-lit room. Damaged eyesight, unlike a cut finger, cannot be cured. The best that can be done is to prescribe spectacles. As the cost of these now falls on the taxpayers, however, is it not possible that by spending money now on improved school lighting and preserving children's eyesight the taxpayers may eventually see their money back in the decreased demand for spectacles, which would be the logical outcome of this improvement?

In the meantime, may we hope that lighting engineers will be able to develop a new lamp which has the high efficiency and low surface brightness of fluorescent tubes, but does not require the expensive auxiliaries which militate, at present, so strongly against their extended use in schools.

# Lighting Research at the Building Research Station

**At Garston a team of architects, scientists, and lighting engineers are concerned with the investigation of lighting problems of practical interest to the builder. Their work includes both natural and artificial lighting. This article briefly describes the scope of the work and how results obtained are applied to practical everyday building problems.**

By R. G. HOPKINSON,
Ph.D., M.I.E.E., F.I.E.S.

Lighting research at the Building Research Station comes within the field of the Architectural Physics Division, which was formed for the purpose of co-ordinating functional studies. The work of this division is directed towards the advance of knowledge readily capable of practical application by the architect and builder. The division includes architects as well as physicists and engineers on its staff, working together in the research teams. It is not possible to define precisely the activities of each of these groups. The architect, by nature of his background and the traditions of his profession, tends to approach problems in broad terms, and he exercises his initiative in this way. He also has the training to present the work of the division in a form which commands the attention of practising architects and builders. Consequently the design work is broadly in the hands of the architect and the experimental work broadly in the hands of the scientist, but there is a great deal of useful overlapping, which assists the scientist to tackle the right problems in an economical manner to yield the most fruitful results, and which enables the architect to appreciate the advantages of the scientific method for problems which can be solved only qualitatively by intuitive observation.

This method of approach to the physical problems of building research has been working now for several years and has already proved itself to have many advantages, the chief of which is to bring experiment and practice into much closer contact than would otherwise be the case.

Lighting research at the Building Research Station proceeds therefore along parallel lines of development: on the one, the fundamental research into functional problems, and on the other the design of windows and of lighting units, the designing of new types of lighting scheme, and, more recently, the co-ordination of ideas developed in both these types of study to enable a logical approach to be made to the use of colour in buildings.

Until recently the Station's work was confined to the natural lighting of buildings, and there is a long tradition of research in this field. This side of the work could therefore with advantage be discussed first.

### Natural Lighting Studies

The appropriate point to take up the story of the Station's work on natural lighting is 1944, the date of publication of Post-War Building Study No. 12, on The Lighting of Buildings.* This report summarised the existing methods of assessing the problems of natural lighting.

Natural lighting has been considered essentially a matter of geometrical optics. This approach to the natural lighting problem owes a great deal to the pioneer work of P. J. Waldram and his contemporaries, who systematised the methods of calculating the amount of light which would penetrate to any given part of a building.

The Waldram diagrams tended to be used only by specialists in the problems of light

* H.M. Stationery Office. Price 2s. 6d.

penetration, as they appeared to be too complex and laborious for use by the architect with a busy practice. Consequently, when the need arose during the war years for a rapid means of calculating the probable daylighting in war-time factories, the B.R.S. designed a series of Daylight Factor Protractors to serve as a simple method of computation.

Their advantages over the Waldram diagrams were that they could be laid on to existing scale plans, elevations, and sections, and the daylight penetration assessed

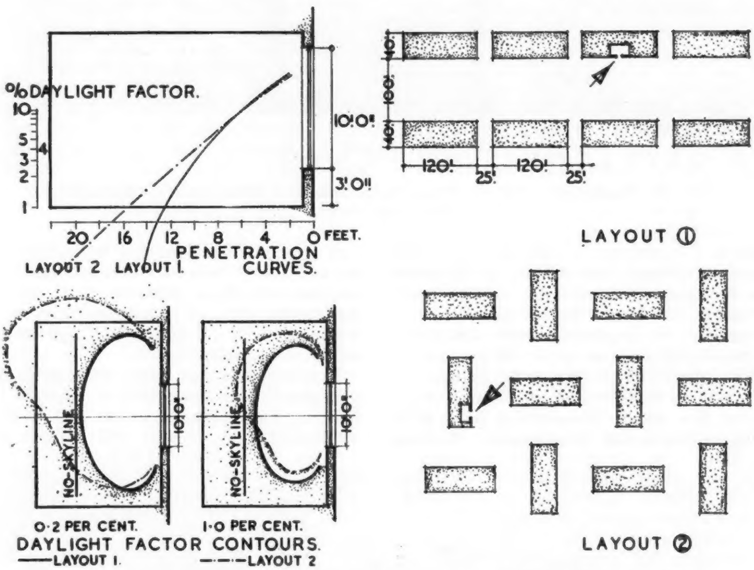



Fig. 1. Daylight penetration can be improved by change of layout from conventional line-development (layout 1) to layout 2.

directly, without a separate plot having to be made; and also that they were tools in a form with which the architect was familiar. Architects have welcomed this attempt to carry the results of research right into their province.

The existence of the protractors accelerated daylighting studies at the B.R.S. itself. They provided a ready means of assessing the relative daylight penetration from different types of window design. Some of the results of these studies were incorporated into the report of the committee responsible for P.W.B.S. No. 12, referred to above, and have been of some influence on the design of new buildings, especially of schools and factories.

Studies were also made of the effect of town planning on daylight penetration. A traditionally planned site (Fig. 1, Layout 1) makes poor use of the available daylight, the lower floors suffering most. Some forms of contemporary planning are little better, and the work of the Station has suggested that large, tall blocks of buildings, spaced carefully in relation to one another, provide the best answer to the problem, giving low angle light even in high density development (Fig. 1, Layout 2). The Waldram diagram here comes into its own in showing clearly the argument behind the Station's work. (Figs. 2 and 3.)

The most recent work on interior daylighting at the B.R.S. has been an appraisal of the methods at present in use for its measurement. It will have been appreciated already that the Waldram diagram and the B.R.S. protractors are geometrical devices for the calculation of daylighting under ideal conditions of uniform sky brightness, and that no allowance is made for the contribution of reflected light from the walls, ceiling, and floor of the room. In practice, therefore, the factor predicted by the dia-

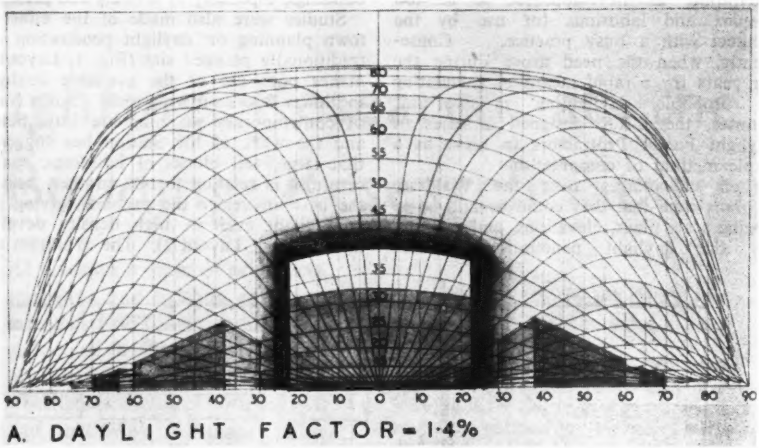



**Fig. 2. Inadequate daylight penetration arising from conventional building layout (not on Fig. 1).**

gram or the protractors will not be realised. The International Commission on Illumination recognised this in 1939, and proposed the use of two terms: (a) the *Sky Factor,* to be used for the geometrical ratio determined by the Waldram diagram or the protractors, and (b) the *Daylight Factor,* to be used for the ratio as measured in an existing building of the actual illumination at a given point to the actual simultaneous illumination from the unobstructed sky. The Daylight Factor therefore would take into account all those matters, such as wall reflections, dirt on windows, uneven sky brightness, etc., which the geometrical calculation omits.

Recently, however, even this added complication in the assessment of daylight in a building has appeared to the Station to be insufficient. A client will often want

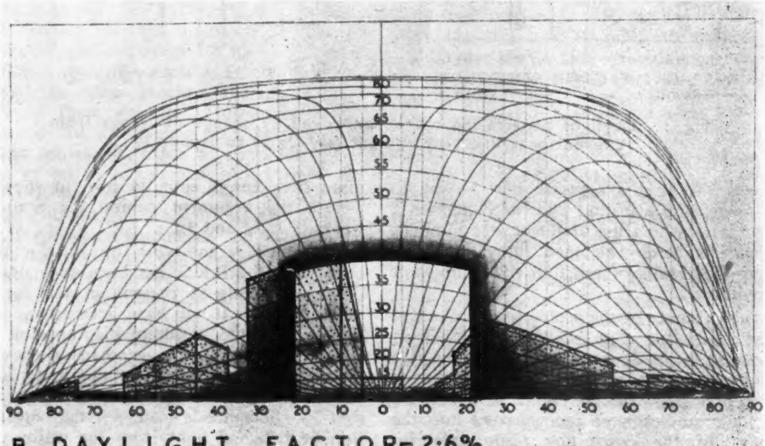



**Fig. 3. Improved daylight penetration arising from layout 2 (Fig. 1).**

measurements to be made in a completed building to check that the promised amount of daylight is in fact being obtained. That is, he wishes to confirm that the predicted Sky Factor is being achieved by the measured Daylight Factor. Unfortunately, this correspondence may not be achieved, through no fault of the designer of the building. The reason is that the light reaching the point in the building is contributed primarily by the patch of sky seen through the window from this point, and not by the whole hemisphere of sky which determines the denominator of the Daylight Factor. Uniformity of sky brightness, though assumed in the Sky Factor calculations, is never achieved in practice, even under completely overcast skies, when the horizon is only one third as bright as the zenith.

The work of the Station, therefore, indicates that yet a third ratio is necessary; this ratio will relate the interior illumination with the brightness of the patch of sky outside the window at the time of the measurement.

This third ratio, for which the only name so far proposed is the Daylight Brightness Factor, serves one purpose, and one purpose only. It serves as a check between the calculated Sky Factor and the lighting actually achieved in the finished building. It should, of course, always be somewhat higher than the Sky Factor, since it will include the contribution of reflected light from the walls and ceiling, etc. But the Daylight Factor, which relates the lighting in the room to that from the whole sky outside, is still the real measure of the overall efficiency of the building as a natural lighting installation.

### The Subjective Approach

In building research, the experimenter has to be equipped with a working knowledge of the basic laws of subjective appraisal, for it will be readily appreciated that the real measure of the efficiency of a building is the assessment made by the occupant himself. Since, in most cases, the building is occupied by very many different individuals, each with their own individual characteristics, the efficiency of the building must be measured in terms of the collective assessment of these occupants.

This collective assessment is a most complex function. In some cases it may be the average of the separate assessments of each individual comprising the population of the building. In other cases it may have to be the assessment of the most sensitive or the most handicapped of these individuals. In most cases both the average and the limiting assessments have to be taken into account and the proper weight assigned to each.

Considerable effort has been made in recent years to assess the effect of the environment on the worker, chiefly by physiologists and experimental psychologists, and as a result, very much more is known about the reactions of the subject to his surroundings. The work of H. C. Weston, of the Medical Research Council, is a well-known example of the application of this type of effort to the lighting field. In spite of the comprehensiveness of these studies, there remain gaps in our knowledge. These gaps need to be filled by laboratory experiments which explore the relationships between the physical variables, and thus form some pattern out of the available experience. This is one of the main purposes behind the experimental work being undertaken at the B.R.S.

It will be recalled that Paterson, in his Guthrie Lecture to the Physical Society on "The Appraisement of Lighting," showed how the real aim of the lighting worker was to be a "brightness engineer." Paterson went on to predict that the next stage was the "contrast engineer," who would plan his lighting installations to give acceptable contrasts for efficient and comfortable vision. This outlook was elaborated by Waldram in his recent presidential address to the Illuminating Engineering Society*.

The B.R.S. work is designed to supply the experimental data needed by the lighting designer, either architect or "brightness engineer." The recent papers by Ward Harrison on Discomfort Glare † were a welcome attempt to get a complex problem into a suitable form for direct application by lighting designers, but experimental backing for the design formulae given was available only partly. The B.R.S. research programme sets out to supply some of this experimental backing.

In order to make studies which involve accurate subjective judgments, care has to be taken in the design of the experiment. Knowledge of the techniques of subjective assessment is at present limited, and so time has had to be spent in exploring simple methods of doing the experiments that are needed. The main reliance is placed on performance tests, and on direct subjective appraisals using the Multiple Criterion Technique. This latter method involves the

* Trans. Illum. Eng. Soc. (London), Vol. XIII, No. 10, 1948.

†See Trans. Illum. Eng. Soc. (London), Vol. XIII, No. 6, 1948.

setting, by the subject, of one variable to correspond, in turn, to each of a series of carefully described borderline criteria of sensation. For example, in a glare study, the criteria of discomfort from glare will be a series such as "just intolerable," "just uncomfortable." and so on, whereas in a visibility study they may be "just visible," "just recognisable," and so on. It has been found, over a period of years, that this type of study is reliable, in that consistent results are obtained, which are of quantitative value.

### Studies of the Appraisal of Lighting

By these and similar means, detailed relationships between the physical quantities which govern discomfort from glare, or ease of reading in classrooms, or the assessment of luminosity of fluorescent and of incandescent lighting, and other subjective factors, have been obtained. Some of these studies have recently been reported in the I.E.S. Transactions * so that it is not necessary to describe them in detail here.

A study was made of the reasons why complaints were often made that fluorescent lighting, especially "daylight" type lighting, appeared to be much less "bright" than incandescent lighting giving the same general illumination level. The explanation usually given for this phenomenon is that the eye, being habitually provided with high levels of illumination in daylight conditions, finds something lacking when lower levels of illumination of the colour of daylight are provided by artificial means. The experiments did not disprove this but forced the suggestion that at least part of the effect may be due to the relative brightness of the light sources. A direct experiment with one enclosure lighted by bare filament lamps and an adjacent enclosure lighted to the same general level on the whole surroundings, but by means of concealed sources, showed that the majority of observers judged the unconcealed lighting to be the "brighter," i.e., they estimated that there was more light available. On the other hand, with enclosures lighted by filament lamps both concealed and visible, and fluorescent lamps of a very wide range of colour both concealed and visible, the observations of those who found the "cold" lighting to be "dull" cancelled out those who judged it to be "bright," in the random sample of 20 observers who made the tests. These results have not been published because it is felt that they are based on experiments insufficiently comprehensive to justify the

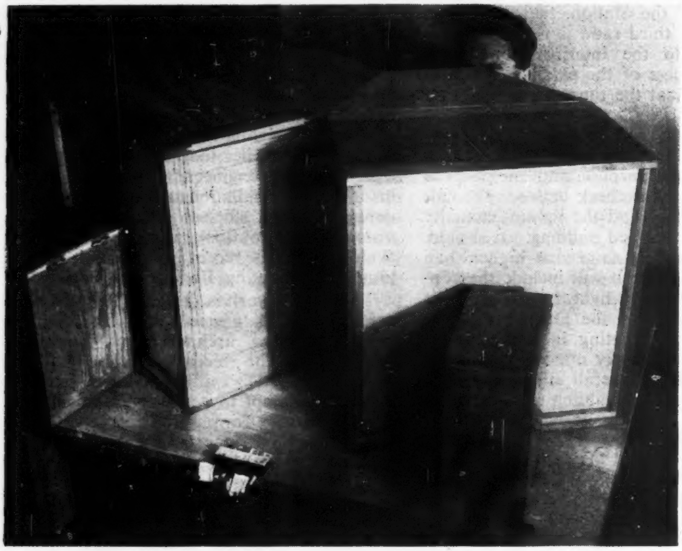


Fig. 4. Luminosity photometer.

* Trans. Illum. Eng. Soc. (London). Vol. XIV. No. 8, 1949.

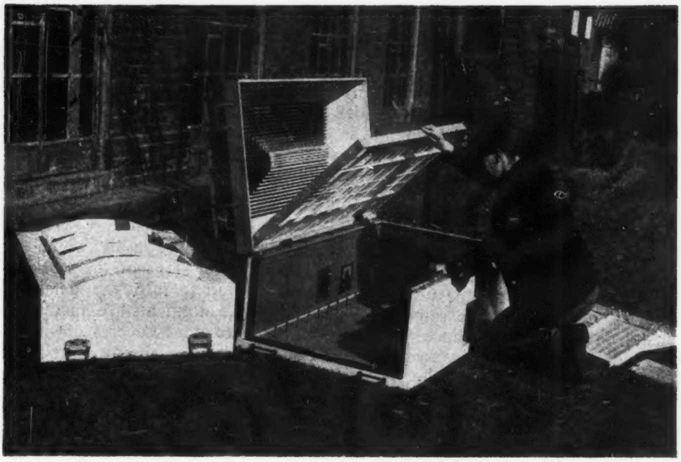


Fig. 5. Louvred ceiling design for National Gallery to give high picture "luminosity."

sweeping conclusions which might be drawn from them. It is, however, hoped to conclude the work when conditions permit, using a sufficiently large number of observers to give confidence in the results.

The work on glare has only recently been reported to the I.E.S.* One of the interesting conclusions from these studies is that much can be gained in visual comfort if the brightness of a fitting is graded into the brightness of the surroundings. Since the study on fluorescent lighting showed that a lighting installation looked "brighter" if the light sources are visible, it follows that by attention to the grading of the source brightness it may be possible to achieve this attractive effect without the usual accompaniment of discomfort from glare. A mock-up fitting which was designed on the Station in connection with a school lighting study confirmed that this is in fact the case. (See Fig. 6.)

The ease of reading studies, which were reported in the I.E.S. Transactions last year†, showed, amongst other things, that the ability of a subject to pass the routine "Snellen" test of visual acuity is not necessarily an accurate assessment of his ability to read intelligible matter. Some people, with good acuity measured by the usual means, need much more light, or need to move much nearer the work, to read as easily as others with the same measured acuity. This factor is of great importance in the judgment of the necessary values of illumination in schools. The studies showed, however, that too much reliance on the provision of large amounts of light to facilitate reading may be misplaced, for the job can often be better done by moving the child nearer to the blackboard. Under average conditions, moving in 3 feet, i.e., from 12 to 9 feet, has the same effect on ease of reading as increasing the illumination on the board by 30 times. This shows how essential it is for the lighting of a schoolroom to be regarded as an integral part of the design of the room, and not merely an adjunct to be handed over to a specialist to do the best he can with an inherently inadequate design of room. Fortunately modern school architects are much more ready than formerly to work with the lighting specialist at an early stage in their design problems.

Other studies of quantitative appraisal of lighting include the experiments to find the tolerable range of colour which can be employed for school chalkboards, when used with white chalk, under good illumination. This work was done to demonstrate to school architects that their colour schemes could include the chalkboard without any need to consider the use of coloured chalks, but, on the other hand, there were some colours which, when used with white chalk, led to visual irritation or discomfort, and which therefore should be carefully avoided.

Some effort is now being directed to the problems of the relationship between

* Trans. Illum. Eng. Soc. (London). Vol. XV, No. 2, 1950.

† Trans. Illum. Eng. Soc. (London) Vol. XIV, No. 8, 1949.

luminance (brightness as measured by the photometer) and luminosity (brightness as assessed subjectively). This is one of the stages in the work on the influence of the brightness of the environment on visual efficiency and comfort, for which the term "Brightness Engineering" is often employed. The apparatus being used for the pilot experiments consists of two enclosures side by side (Fig. 4), each of which provides a surround brightness around a test patch of approximately 3 deg. square. The surround brightnesses are held at different levels, and the observer's task is to adjust the brightness (luminosity) of one patch until it is the same as the luminosity of the other. Since the surrounds are different, the luminances of the test patches which yield equal luminosities will not be the same. By a step method, a series of equal-luminosity curves can be obtained, relating the luminance of the test patch with that of the surrounds. In these judgments the observer is actually not asked to judge equality of luminosity, but is given a series of criteria of inequality, from which the equality point can be deduced. This method gives more confidence to the observer than either the judgment of equality, or judgment of whether pre-set adjustments of the patch are "brighter" or "darker." It is believed the method is more accurate, although tests to find this out have not yet been completed.

Stages of this programme include the effect on visual acuity of the luminosity of the visual task, as opposed to its luminance, and the effect of size and brightness of the surroundings on visual acuity. The apparatus for this work is now under construction

### Lighting Design

The experimental programme is intended to integrate with the design work, so that the experimental results can be applied with the least delay, and hence tested out under practical conditions. The design work in turn produces its own problems, which call for experimental studies.

The design work can be grouped under three broad headings, (a) studies of the lighting of building types, (b) design of lighting systems and fittings, and (c) consultations on the lighting of specific buildings. In all three, both natural and artificial lighting problems are given equal attention by the same team.

Work on building types usually starts with visits by a study group to buildings which can be considered representative of this type. The main points which need consideration are studied, and usually a large number of brightness, illumination, and colour measurements are made, and photographs taken. The secretary of the study group then drafts the group's report, and on this the necessary experimental or design work is based. Building types which have so far been handled in this way include art galleries, schools, factories, and hospitals.

The proposals which arise out of the second stage of the work are usually incorporated into a detailed model study. Measurements are made in the model, which enable the success of the design to be estimated and any necessary modifications made. Figure 5 shows a model made to appraise the design of a new natural lighting system for the National Gallery. This system includes a series of louvres which restricts the light to the pictures themselves. The surroundings are therefore much darker than would otherwise be the case. As a result, the *luminosity* of the pictures is much higher than by the unrestricted lighting, even though the *luminance* is slightly reduced by the obscuration caused by the thickness of the louvres. A design for the Birmingham Art Gallery, in which the same principles were applied, was described in the July issue of this journal.

The natural lighting of hospitals is being studied from first principles. A new approach to the lay-out of a hospital is being considered, in which the system laid down in the mid-nineteenth century is not necessarily regarded as an essential feature of the design. The model ward is provided with a large number of rectifier photoelectric cells fixed in significant positions. Any of these cells can be rapidly selected, and the illumination at that position measured. In this way the effect of change of window lay-out, internal screening, reflection factor of walls, etc., can be assessed rapidly. The subjective aspect, for example, freedom from sky glare, can also be appraised, the observer viewing the model ward through the floor, which has removable panels. The illumination of the model is provided by a specially designed artificial sky.

Detailed studies of the natural lighting in these models is undertaken, using either the natural sky when conditions permit, or artificial skies constructed for the purpose. An all-purpose artificial sky is, however, under construction for these studies, which are expanding in their scope, and this will

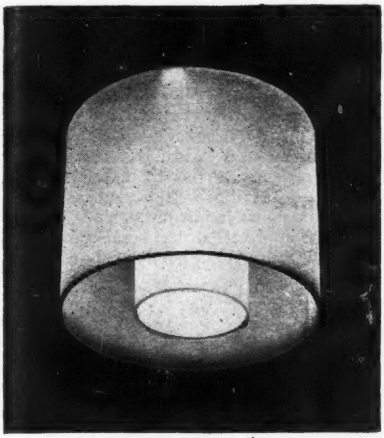


Fig. 6. Filament unit designed on the "contrast grading" principle.

also include a Heliodon for the study of sun penetration.

Model studies on the lighting of factories have to take into account a much wider range of conditions than are experienced in most other building types. For this reason, the factories' work is being done with a model system on the "Meccano" principle, in which bits and pieces can be assembled readily for any particular type of factory. The use of transparent plastic materials greatly facilitates this work, since windows and roof lights can be fashioned to particular shapes much more easily, and with less chance of breakage, than if glass were used.

Work on the design of lighting fittings derives from two distinct approaches. Originally, the need arose for a design of fitting to try out the effect in practice of some findings in connection with the studies on discomfort glare. These fittings, which employed the "contrast grading" method referred to earlier, happened to be ready at the same time that a decision was required in connection with a school lighting programme, and so they were erected in a school classroom as part of a trial of different types of fitting. Following this, work was put in hand at the Station, in collaboration with the County Authority conducting the tests, to design a series of lighting units employing these principles. Fig. 6 shows the original unit, and Fig. 7 a development of it.

The other approach arose out of the need expressed by many contemporary architects that some type of unit for fluorescent lighting was needed, more simple in design than those generally available. A series of units has been designed, which incorporates the findings of the experimental work on the permissible maximum brightness of a unit to give acceptable freedom from discomfort glare. Fig. 8 shows one of these units for general use. Fig. 9 shows a unit designed on the same principle, for fixing to the roof girders of a factory. Fig. 10 shows an installation of these units.

Consultations on the lighting of specific buildings are not part of the Station's general

Fig. 7. Filament unit developed from Fig. 6.

programme, but some work of this kind is valuable in order that practical experience with problems can be obtained. As far as possible, studies are undertaken only if some useful knowledge or experience is likely to be acquired in the course of the work. The Station is, of course, available, as are the other branches of the D.S.I.R., to undertake Special Investigations, and these include detailed surveys of both natural and artificial lighting systems.

### Colour

A lighting system must necessarily include the reflection characteristics of the surfaces on which the light falls. In order to simplify the problem, lighting engineers usually assess the brightness of the surroundings in terms of monochrome, but the architect must necessarily see the problem in terms of colour as

well. This introduces complications, but it also gives assistance in the task of providing comfortable seeing conditions.

In spite of an extensive literature, relatively little is known of the precise effects of colour on visual comfort and efficiency. The broad principles are understood, but do not find sufficient general application. Colour schemes are often designed primarily to make the working places look clean and cheerful, but if this is done without care, adverse colour effects may result which seriously reduce visual efficiency, for example, if the colour of the work and its immediate background are so alike that there is no effective contrast between them.

Detailed study of colour in factories, schools, and other work places over a period of years, together with an appraisal of the various experimental studies which have been made here and in other countries, now enables us to approach colour problems in a more comprehensive and exact manner than hitherto. This approach divides itself into (a) emotional objectives, (b) visual restraints, and (c) practical limitations. The latter come primarily within the province of the paint and colour technician. The first two are the concern of the lighting section, and to fill the gaps in knowledge which exist, full use has to be made of subjective judgments. The experimental work on the emotional aspects of colour requires the techniques of the experimental psychologist, whilst the visual problems are studied by the same general methods as those used for the general lighting research work. It is, in fact, not possible to define where colour research and lighting research divide—they are each equally important branches of visual research. The psychological aspect is particularly pronounced in colour research, because colour makes a major contribution to the character of an interior. In the analysis of the colour treatment of schools and hospitals, and particularly factories, the colours which will give the right character are investigated, as well as the requirements of visual comfort and efficiency. The training of the architect enables him to make a particularly useful contribution to these studies.

The purpose of the research on colour is to define the colour treatment of a building on a complete and logical basis. The work done so far enables this to be achieved on broad lines, but much detailed investigation in the form of experimental work is needed. It must be appreciated that good colour, like good lighting, cannot be defined in a precisely formal fashion. Even when the basic principles have been formulated, the skill and artistic good sense of the colour consultant still have a valuable part to play.

**Instrumentation**

For the work on subjective judgments, it is taken as a working rule that the photometry should be at least 10 times as accurate as the accuracy of the subjective observations. In practice, this means that the apparatus used for subjective studies can be calibrated with visual photometers of the Macbeth type. The section calibrates its own instruments regularly against a series of sub-standard lamps, some of which are calibrated at the N.P.L., and others come

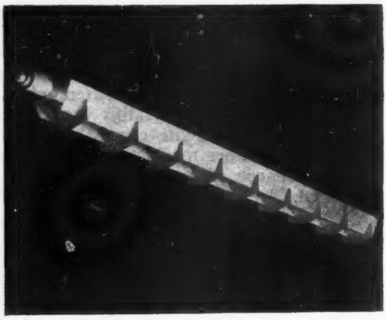


Fig. 8. Fluorescent unit for general lighting.

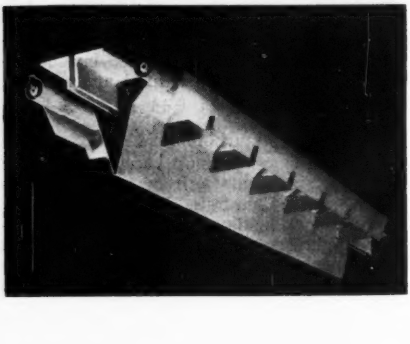


Fig. 9. Dual fluorescent unit for industrial lighting.

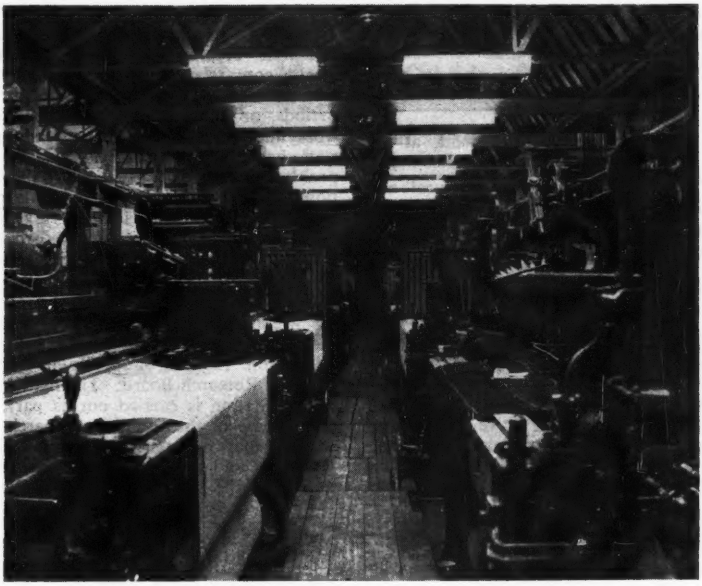


Fig. 10. Installation of fluorescent units in a woollen mill. Note also the filament "spots" to give "texture."

from the standards sections of other organisations. A series of routine standards is used for the normal work of calibrations, but other master reference standards are kept for cross-checks. In the same way, reflection standards are kept, which are cross-checked with one another. Both lamps and reflection standards, and occasionally photometers, are sent to the N.P.L. for checking, and the usual cross-checks with other organisations are also made. A G.E.C. Universal Photoelectric Photometer is used for comparison work, especially that involving the comparison of light from sources of different colour. The C.I.E. standard illuminants B and C are used for the calibration of photometers to be used for daylight measurements.

Routine measurements of Daylight Factor are made primarily with a Schuil telephotometer, as this instrument has many features which make it very suitable for this purpose, including a built-in inclinometer to give the elevation of the patch of sky being measured. Experience has shown the technique at present in use to be both rapid and sufficiently reliable for the purposes in mind.

A small portable direct-reading Daylight Factor meter for routine studies is being made up. This incorporates a rectifier photocell with a logarithmic-scale micro-ammeter.

Colour measurements are made exclusively with a range of Munsell atlases. A tricolorimeter was made up at an early stage of the work, but experience has shown that, for the type of work which the Station is now doing, the Munsell system is far more useful than any other at present available. It is intended to obtain a recording spectrophotometer, once the colour work has reached the stage where full use could be made of the instrument.

Colour photography is used, but the accuracy of routine colour photography is not yet adequate for the task of the faithful recording of most colour schemes. Black-and-white photography is also used extensively, and photographic photometry will be used during the next stages of the environmental brightness studies. No attempts have been made to work a system of standard representation photography, as the limitations of the photographic medium are much more serious than in the case of the lighted

streets (for which the technique was devised). A disproportionate amount of work would be needed to maintain a sufficiently high standard.

### Conclusion

The objects of the lighting work at the B.R.S. are :—

(a) To co-ordinate the architectural and the engineering aspects of lighting design, and to act as an advisory organisation for builders who have natural or artificial lighting problems, putting them in touch with the authorities in any special field.

(b) To undertake work on the subjective aspects of lighting, to bridge the gap between the knowledge of the physiologist and the engineer, and to provide design data on these aspects for use by the builder.

The Station takes an active part in the work of the National Illumination Committee, and members of the staff serve on the Daylight, Architectural Lighting, Museum, and Light and Vision sub-committees, as well as on the main committee.

Members of the staffs of the Building Research organisations in the Commonwealth countries visit the Station to work as members of the staff during their training periods, or to effect a closer liaison of the work, and recently a member of the Station's staff has toured British Africa, to study problems which are peculiar to the conditions there. Co-operation with European organisations, which was lost during the war, is being built up again, largely through the work of the International Commission on Illumination.

Close co-operation is also maintained with the Medical Research Council, members of the Station staff serving on the Joint Committee on Lighting and Vision with the Building Research Board. The lighting work of the Station is carried out as part of the programme of the Building Research Board of the Department of Scientific and Industrial Research, and this note is published by permission of the Director of Building Research.

# Obituary

## PERCY GOOD

It is with the deepest regret that we announce the death at his home on December 2, of Mr. Percy Good.

Born in London in 1880, he joined the British Engineering Standards Association as Assistant Secretary in 1913, was appointed Deputy Director of the B.S.I. in 1929 and Director in 1942. He was President of the I.E.S. 1938-39 and President of the I.E.E. 1947-48. He was also a member of the Executive Committee of the National Physical Laboratory.

His contributions to lighting were of the highest order, and he was awarded the C.B.E. for his services as Chairman of the Joint Lighting Committee of the Ministry of Home Security and the Illuminating Engineering Society during the period 1939-45. This Committee was formed in June, 1939, with the job of reporting on any lighting problems expressly referred to it by the Ministry of Home Security. The subjects considered by the Committee included every aspect of lighting in war time, and the work of the Committee was of considerable value to the country during those difficult years.

Mr. Good will also be remembered for the part he played in the organisation of the International Illumination Congress in this country in 1931 when, as chairman of the London Committee, he was responsible for the first large-scale floodlighting ever seen in this country. The drive and energy of Mr. Good enabled the many prominent buildings and monuments to be lit up at night, thereby contributing so much to the enjoyment of Londoners and visitors to London at that time and laying the foundations for such lighting on future occasions. The crowds which gathered to see the illuminations were the largest London had ever known.

Mr. Good was respected by all with whom he came into contact for his industry and kindness. He leaves a widow and one son to whom we extend our sincere sympathy.

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Messrs. Falk Stadelmann and Co., Ltd., announce the opening of three new branches: *Home* (*Electrical*), 42, Hertford-street, Brighton, 7, Sussex; and 23, Market-lane, Newcastle-under-Lyme. *Overseas* (*General*), 45, Church-street, Bloemfontein, Orange Free State, South Africa.

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The General Electric Company, Ltd., supplied the equipment for the coloured lights on the Christmas tree, illustrated on Page 4.

# Random Review of 1950

**The following comments are, as the title indicates, the reflections of but one lighting engineer on the events of the past year. Limitations of space and time make it impossible to deal with every development in the lighting field.**

By B. F. W. BESEMER

### Lamps

"The Operation and Maintenance of Fluorescent Lamp Installations," by Messrs. Stoyle and Jones-Thomas, which formed the subject of the first issue of the 1950 I.E.S. "Transactions," was timely indeed. The tabulated information summarised countless leaflets of colours, models, outputs, control gear and circuits of this Peter Pan of lamps, and, but for the fact that the "Mellow" lamp was put on the market a few weeks beforehand, the paper would have been up to date when it was published in "Transactions." Though the control gear to-day is infinitely more reliable than it was a few years ago, it is still necessary at times to search beyond the lamp itself when a fluorescent lamp gives trouble, and the authors' methods of tracking the fault are worthy of Scotland Yard itself.

The introduction of the "Mellow" lamp by the members of the Electric Lamp Manufacturers' Association at the beginning of the year marks a further and, we trust, final stage in reaching that elusive goal, an efficient fluorescent lamp giving light of a generally acceptable colour. Now that the "Mellow" lamp is available in a variety of sizes, all that is needed to make fluorescent lamps popular in the home is simple control gear at seven-and-six per set.

Mr. E. A. Langsdon's lecture to various I.E.S. centres and groups on "Cold Cathode Lighting" dealt with a subject comparatively neglected in this country. Our French friends, to whom the hot cathode fluorescent lamp was unknown until after the war, have shown us something of what can be done with cold cathode lighting. It has the promise of enormous development in Britain if it can be marketed more cheaply than it is at present. There have, however, been a number of notable installations of cold cathode lamps during the year, the most outstanding being in the Chamber of the House of Commons, which has already been adequately described in this journal and in a paper to the I.E.S. Though we were not able to be present at Mr. Brown's paper in London, we understand that comments on the installation were all favourable — which, after the adverse criticism which has appeared in the popular Press, may seem a little surprising. And, in case anyone should think that this is just a case of lighting engineers patting one another on the back, we might recall that discussions at I.E.S. meetings in London can be quite frank—though most gentlemanly, of course. Other installations of cold cathode lamps include the Rugby Theatre, the new Ocean Terminal at Southampton and a number of shops and restaurants.

"The Gas Arc," by Mr. H. W. Cummings, in LIGHT AND LIGHTING is the last word in published information to date on this phenomenon with its circumscribed but substantially uncontested field of use. Does it hold the key to major lamp developments of the future?

### Fittings

Lighting a manual telephone switchboard is always something of a problem to the conscientious lighting engineer because optimum lighting requirements for closely adjacent parts are incompatible. The fitting described by Mr. Bellchambers in LIGHT AND LIGHTING last September, and shown in the sectional drawing herewith, embodies both local and general lighting and appears to go a long way towards a satisfactory solution, provided that operators

can be persuaded to change their invariable custom of keeping heavy directories on top of the board. As the fitting forms an integral part of the switchboard, can we hope that the Post Office authorities may supply the private branch exchange of the future already fitted with its lighting equipment?

The Atlas "Home Unit" marks a welcome break from the conventional. An indirect domestic lighting fitting which can be hooked on to any picture rail and retails at less than three pounds complete with fluorescent lamp and control gear demands notice in any review of the year.

The new Ocean Terminal at Southampton Docks, which was opened by the Prime Minister last July, provides examples of "functional" lighting by standard equipment, but some of the few intensities quoted are disquieting indeed. Four foot-candles in the ground-floor goods-handling department! How fortunate for the authorities concerned that it does not come under the Factories Act.

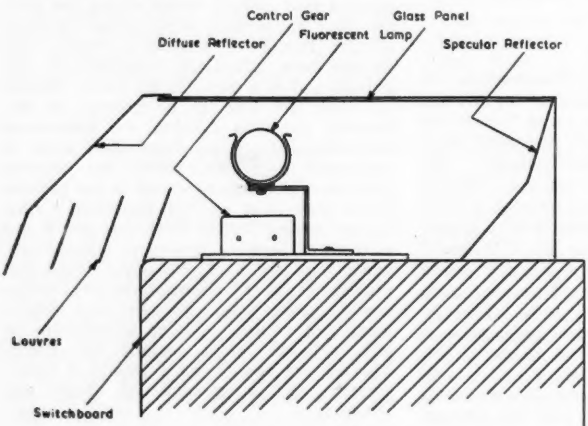
In a letter to LIGHT AND LIGHTING, published last August, Mr. Martin Barnicott makes a cogent contribution to the problem of fittings design in general as well as a spirited defence of the Council of Industrial Design. The Council and its members have certainly produced some excellent designs in happy contrast to some of the "jazz-modern" stuff to which Mr. Barnicott refers. Our only criticism of the Council is the low loading and consequent high "cost per lumen" of so many of its members' designs. Few of us can afford many fittings in our rooms at home, nor do we possess the wiring points, but, in these days of cheap electricity and lamps, and high intensities, we can use well-designed domestic fittings with plenty of watts inside and large low-brightness surfaces outside.

"Lumeritas" damned with very faint praise a Chelsea shop in which the lighting fittings consisted of "inverted sunshades." With the possible exception of the absorption factor, what is the difference between sunshades and any other semi-indirect medium? The Chelsea shopkeeper should be congratulated on his originality. This spirit of enterprise is certainly one aspect of lighting where our Continental neighbours can teach us a lot.

**Street Lighting**

From Monsieur Boereboom's summary of "Fluorescent Street Lighting in Belgium," it is interesting to note that "the large majority" of the 4,000 units installed were of the "ordinary type with an opal diffuser." It is noted also that, in common with many other users, the author hopes for lamps of smaller dimensions. We wonder whether the ultimate lamp for street lighting will prove to be a compact source or a continuous line source of low surface-brightness. We are still very far from resolving the basic requirements in this field. In the meantime, installations using mercury, sodium and fluorescent lamps seem to be going up all over the country, whilst gas holds its own on London Bridge and in Hyde Park.

The issue of the French recommendations for street lighting preceded the issue of the British draft code of practice for Group "A"




Sectional drawing of the switchboard fitting designed by the B.T.H. Co. for lighting a group of switchboards in a private branch exchange.
*(B.T.H. illustration.)*

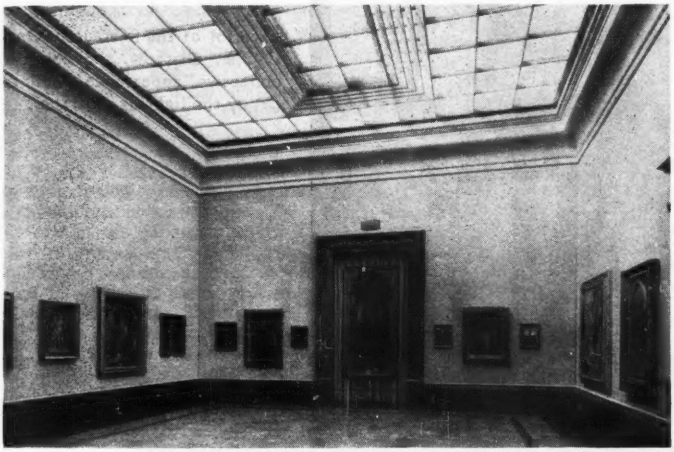
roads by only a few months. The latter has not escaped quite severe criticism but it is, none the less, a useful document.

**Other Applications**

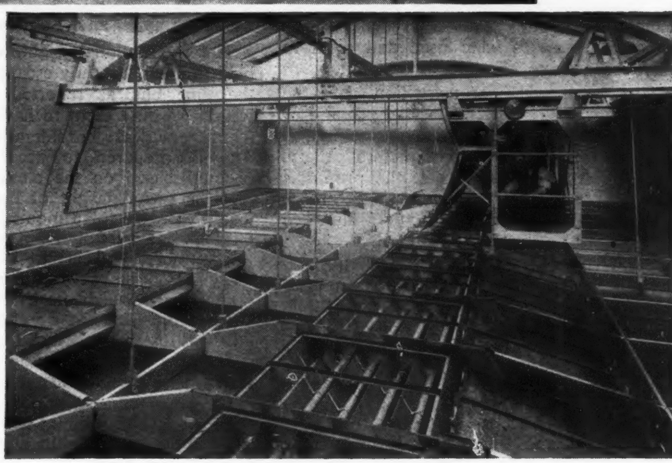
In both the new M.V. Oslofjord and the refitted Empress of Scotland cold cathode lighting predominates, the latter using what is believed to be the record length of 5,000 ft. of fluorescent tubing.

In the course of the masterly paper on "Visual Aids for Landing in Bad Visibility," delivered to the I.E.S. by Mr. E. S. Calvert, and the no less interesting contributions to the discussion made by some of the leading B.O.A.C. pilots and others, the extent of the British contribution to the solution of this key problem to flying safety throughout the world was demonstrated in no uncertain manner.

It seems that the lighting at the National Gallery has been under discussion ever since we took any interest in lighting. An experiment recently completed in Gallery XXIX involved air conditioning and lighting.



A view* of Gallery XXIX at the National Gallery showing the daytime appearance.



Showing the arrangement of lamps and louvres above the laylight in Gallery XXIX. Some of the glazing panels are removed for access to lamps.

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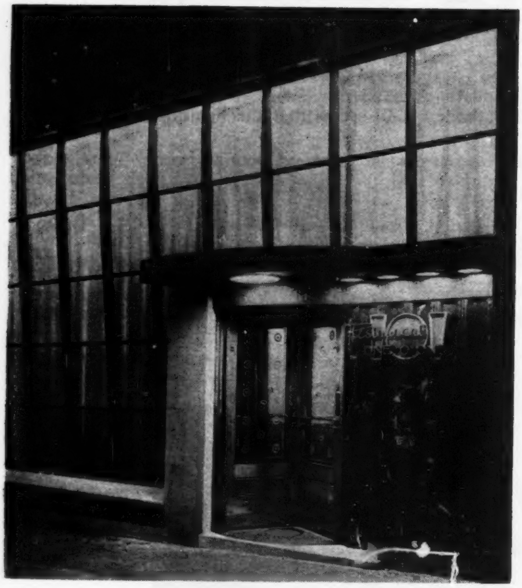


Exterior of the Restaurant One-O-One, Glasgow, showing the attractive appearance obtained by the lighting of drapes.
*(G.E.C. photograph)*

Fluorescent lamps with a laylight and a system of louvres were used and seem to have been quite effective.

The proposed reconstruction of the Birmingham Art Gallery has the promise of a really satisfactory solution to the thorny problem of how to light a picture gallery. It is interesting to note that the proposals basically bear a strong resemblance to those proposed—but rejected—exactly a hundred years ago for the National Gallery.

Similarly, as LIGHT AND LIGHTING records, the proposal to use a wavelength of light as the fundamental standard of length, in place of the present arbitrary distance which has no true natural basis, reminds us that nearly 4,000 years ago the Chinese used a standard of length based on the wave-length of sound. *Plus ça change, plus c'est la même chose.*

In last year's "Random Review" we referred to the lighting of Beverley Minster. The subsequent lighting of the choir is sufficiently novel to compel further notice. There are six specially designed fittings which consist of oak standards supporting octagonal bronze vase-shaped reflectors, each of which houses a 200-watt lamp, each fitting being separately controlled by a switch under the book-rest of the choir stall.

**Empire and Foreign Notes**

The International Lighthouse Conference held in Paris last July escaped our notice at the time but, as reported, discussions on visibility would seem to have strayed rather from practical considerations at times. Though prepared to accept a calculated distance based on the elevation of a light and his own "height of eye," no mariner would consider for a moment any "distance off" tabulated simply from sighting the light. Furthermore, visibility at a vessel 20 miles away may be very different from the visibility at the light itself and very different again from that at another vessel on a different distance, so that to vary the intensity of the beam according to the visibility could cause much confusion.

If buoys come within the scope of the conference, we submit, with respect, from years of minesweeping by night in notoriously foggy waters, that a little spill light on to the buoy itself would often give the mariner some opportunity of judging his distance from a lighted buoy. Perhaps Trinity House would give consideration to this point as a possible item for the 1954 conference.

In the course of his address at the summer meeting of the I.E.S., Mr. Folcker, the President of the Swedish I.E.S., made the

interesting point that the practice in Sweden with fluorescent lighting is to confine the use of the "daylight" lamp to intensities above 30 foot-candles and the "white" (roughly our "natural") to a minimum of 15 foot-candles as neither is psychologically satisfactory at lower values which are reserved for the warmer coloured lamps. From the time when man discovered fire, better light to him has always been synonymous with whiter light, so it looks as though the Swedes have reason on their side.

But Mr. Folcker is not the only contact we have had with other countries during the year under review. We are always glad to welcome lighting engineers from other countries; the I.E.S. Summer Meeting was a good opportunity, and we are glad that Jean Chappat was invited to open the discussion on one of the papers at Buxton. Contributors to this journal have provided other contacts. Lighting practice in other countries is worthy of study, and we should be grateful to those contributors, amongst whom we are pleased to see Ward Harrison and S. G. Hibben, who have brought us news of developments in other parts of the world.

### Colour and Decoration

The survey taken among the visitors by the Wool Industries Research Association at their exhibition of colour-matching lamps, held at Leeds in conjunction with the local I.E.S. Centre, is probably the most widely cast survey yet obtained on this difficult subject. It confirms the theory that, whilst the standard of colour-matching lamps in general is high, blended fluorescent and filtered tungsten are the best.

### Materia Medica

The distinction accorded to the I.E.S. President, Doctor Aldington, of addressing the British Medical Association at its annual conference is an honour in the reflected glory of which all members of the Illuminating Engineering Society can bask. Man is using artificial light more and more and it is good to find the medical profession recognising the value of the knowledge which the Society possesses on the subject.

The lighting exhibition arranged by the I.E.S. at the International Congress of Ophthalmology was an outstanding success, and is to the credit of all concerned. We hope that opportunity may arise to display the exhibits to a wider audience.

Those, if any, who still cling to the belief that fluorescent lighting is a harmful and dangerous thing must have been rather disturbed that the new National Institute for Medical Research is lighted almost entirely with fluorescent lamps. On the other hand, perhaps they were no more impressed by this than by the fact that various other buildings connected with the medical profession

Showing foundry lighting by means of blended lighting with units each of which houses one 1,000 w. tungsten lamp and two 400 w. mercury vapour lamps. The units were designed by the B.T.H. Co. *(B.T.H. photograph.)*


Exterior of a shop in Old Bond Street showing the striking effect of the concealed lighting on rolls of cloth in showcases recessed in the walls.

are, and have been for some time, lighted in this way. There do not, however, seem to be as many alleged complaints about fluorescent lighting as there were a year or two ago.

Mr. K. J. Mitchell's article in September's LIGHT AND LIGHTING on "Lighting in Relation to Plant Growth," is an excellent guide to a subject which can provide incalculable interest for the amateur urban gardener. It does not seem generally to be realised that artificial lighting can delay development as well as hasten it and provide many out-of-season oddities. Furthermore, there is still

Showing a wall display in Richards Shop, Regent Street, lit with fluorescent lamps concealed from view by a false ceiling in which are recessed reflector spotlights providing lighting for the counter.

quite a large field open to the amateur for pioneer experimental work on individual species of plants.

**Miscellaneous**

The rebuilt Illuminations Collection at the South Kensington Science Museum, which was completed this year, is a masterly example of *multum in parvo*. Our only regret was that means could not be devised to permit the operation of all the working exhibits without the intervention of an attendant.

It is encouraging to note that, in spite of all the technicalities that the I.E.S. discuss from time to time, the subject of domestic lighting, though it still does not feature as the subject of a paper at their London meetings or in the "Transactions," is not entirely forgotten. Two recent Past-Presidents of the Society have mentioned it in their Presidential Addresses, and one of them, Dr. Aldington, followed up his own challenge during the year by an article on the subject.

Dame Caroline Haslett's article on "Light in the Home," in the March issue of LIGHT AND LIGHTING, is both concise and pertinent as is everything from the pen of the distinguished founder of the Electrical Association for Women. Her first point—"How much will it cost?"—goes straight to the heart of the matter. The lamp-makers and the supply industry have put the running cost of good lighting within the reach of all of us, but capital cost is the stumbling block. It will continue to be so until the lighting, preferably built-in, is included in the house rent or purchase price. The lights ceased to be an extra on motor-cars 30 years ago, but they still remain so on houses—an anachronism indeed.

We have also watched with more than passing interest the contributions in this journal from another author (we assume it is only one author) whose name is not mentioned but who is obviously the champion of new ideas and innovation in this most important field. Maybe, the preparation of a paper to the I.E.S. on domestic lighting presents some difficulties, but surely there are some indications that there is material available—and unless the Society gives a lead, then surely architects and housing authorities will continue to supply the single dangling pendant which has so often been deplored. Dr. Aldington has said that we shall be doing wrong if we do not press for new standards of home lighting.

The spate of articles on window lighting and kindred subjects which appeared in the Press in the course of the year is a reminder that shop-window lighting has been banned in Great Britain for ten years.

Doctor Walsh's article on "Optics and Photometry at the N.P.L," in last April's issue of LIGHT AND LIGHTING, was timely in 1950, the National Physical Laboratory's Jubilee Year, and will have opened the eyes of many to numerous unsuspected activities of the N.P.L.

The final article of that excellent series by Mr. S. S. Beggs, "Problems in Illuminating Engineering for Students," which appeared in LIGHT AND LIGHTING during the year, must not be overlooked. Mr. Beggs concludes by disclaiming that his articles constitute a comprehensive course for the City and Guilds of London Institute's final examination in lighting, and mentions that no text-book for that purpose exists at present.* Well! What is Mr. Beggs waiting for?

The experience of "Lumeritas," who, seeking advice on the lighting of his study, was told at the local Service Centre of his Electricity Board that "we don't measure illumination" and that they had "never heard of recommended values of lighting," was regrettable, but present shortages and restrictions, couched usually in terms of load or watts per square foot, impress watts rather than foot-candles or lumens in the minds of the uninitiated. We feel that "Lumeritas" must have had the misfortune to inquire from a rather new member of his Service Centre staff.

Some advances in the technique of stage lighting have been made this year and valuable contributions have been added to the literature on this subject. The paper by Dr. J. W. Strange on the dimming of fluorescent lamps and its application to the theatre caused considerable interest, whilst Mr. L. G. Applebee's paper at the I.E.S. summer meeting gave a very excellent review of the present state of the art.

Floodlighting is, without doubt, a subject of which we will see much more in the present year. It was with this in mind, we imagine, that the I.E.S. asked Mr. Ackerley to give a paper at Buxton. Floodlighting is such a simple subject to most people who are prepared to tackle it without any knowledge of the pros and cons—hence the disappointing results so often seen. Perhaps it is the very description (floodlighting) that is the cause of the trouble; anyone can flood light on to a building, just as anyone can throw paint on to a canvas, and the effect in both cases would be just about equally aesthetically satisfying. It would be interesting to hear of suggestions for a new name.

* "Principles of Lighting," by W. R. Stevens, now in preparation, to be published by Constable and Co., Ltd., this summer at approx. 2 gns.

# High Bay Lighting with Mercury Vapour Lamps

**Though not entirely new, it would seem that interest is growing in the use of blended lighting for certain industrial applications. The following article describes one such installation in detail.**

By J. N. HULL,*
B.Sc. (Eng.), A.M.I.E.E., F.I.E.S.

Developments in industrial lighting during the past ten years have been mainly concerned with exploiting the advantages of efficient high quality "shadowless and glare-free" illumination offered by tubular fluorescent lamps. Many small and medium-size factory buildings for which fluorescent lamps are suitable were relit for wartime and postwar products in accordance with modern standards; owing to the low mounting heights employed servicing was generally not difficult, although the number of lamps needed with the larger floor areas may have made it quite expensive.

In some of the larger buildings, the difficulty of servicing and the complication of installing many lighting units of comparatively low power—as the largest fluorescent lamp used in factories is 80-watt—led to the use of 400 or 250-watt MA. mercury vapour lamps, sometimes in multiple units for ease of servicing where the proportions of the building allowed. Colour modification was obtained where necessary by adding some light from tungsten filament lamps. A recently developed high bay unit (Fig. 1) contains two 400-watt MA. mercury vapour lamps operating horizontally in specular trough reflectors and one 1,000-watt tungsten filament lamp in a concentrating vitreous enamelled industrial reflector of conventional design, the reflectors being made easily removable for servicing. For the very large factory buildings now under construction in several parts of the country for manufacturing steel, sheet metals, large machinery, etc., even this unit, which has an average lamp output of 46,600 lumens, presents some servicing problems owing to the numbers required, the difficulty of access and the dirty atmospheres often produced by the factory processes.

### Optimum Lumens per Lighting Unit

A survey was made of the dimensions of several new large buildings with high bays to find the largest size of lighting unit which could be installed. For ease of servicing it is desirable to have as few units as possible, but the limit is set by the maximum spacing allowable for evenness of illumination and avoidance of glare. The light output from each unit is then governed by the illumination required and the coefficient of utilisation, a factor dependent upon the type of light distribution and the proportions of the room.

From a general review of these factors the highest value of lamp lumens which could be used was considered to be about 150,000 lumens.

Multilamp units containing the types of lamp normally used for industrial lighting —fluorescent, mercury, tungsten, or mercury and tungsten—were first considered, but the large numbers required in each unit render these systems undesirable. Attention was therefore given to new designs of higher power mercury vapour lamps, several offering possible solutions. The high brightness (which is useful for optical re-direction, referred to later) and the possibility of colour modification made the ME. quartz lamp appear attractive, but the disadvantages of its comparatively high cost, short

* Formerly with the Research Laboratory, the B.T.H. Co., Ltd., Rugby.

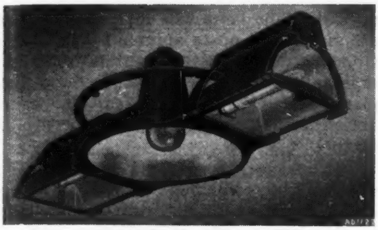


Fig. 1. Mixed light fitting employing two 400-watt MA. mercury vapour lamps and one 1,000-watt G.L.S. tungsten lamp.

life, and the need for an enclosure to absorb ultra-violet radiation, made it unsuitable.

In the MA. hard glass type of lamp the choice was narrowed to a 2- to 3-kw. design about 2 ft. long operating from 200 to 250-volt mains with choke stabilisation, and a 3-kw. 4 ft. lamp requiring a high voltage reactive transformer. The simpler circuit and smaller reflector size made the former the more attractive.

**Colour Modification By Tungsten Lamps**

It is standard practice in most factory lighting installations using mercury vapour lamps to add tungsten filament lamps to improve the colour rendering. The proportion of tungsten lighting is governed by the need for colour discrimination in the visual task, for good appearance of complexions, or for other psychological reasons.

While it is generally recognised that an equal lumen mixture of mercury and tungsten gives very good colour rendering, the overall efficiency of such a scheme is comparatively low—approximately 30 lumens per watt—so for the bulk of installations under consideration a ratio of two-thirds mercury and one-third tungsten is proposed. Field tests are as yet insufficient to indicate whether this will be generally acceptable.

With a figure of 150,000 lumens per lighting unit about 100,000 lumens are thus to be provided by mercury lamps and 50,000 lumens by tungsten. These values of light output can be obtained conveniently from lamps of about 2½-kw. mercury and 3-kw. tungsten. In the discussion above several assumptions regarding proportions of buildings, efficiency of the lighting unit and the coefficient of utilisation have been made. These will now be examined in detail, considering the example of a particular factory building and the lighting unit designed for it.

**The Building**

A new building, illustrated in Fig. 2, has recently been completed for the manufacture of large equipment and required a general illumination of 10 to 15 lumens per sq. ft. of good colour. The dimensions of the main bay are 90 ft. x 500 ft. and the height to the underside of the roof girders is 62 ft. Cranes preclude suspension of the general lighting units below the girders, and it was considered undesirable to use the cranes for servicing them.

A narrow light distribution in the plane across the width of the building is clearly desirable as, using two rows of units along

Fig. 2. Showing part of a factory equipped with high bay lighting.

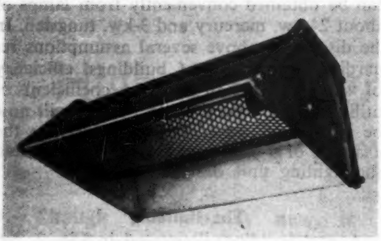


Fig. 3. High bay reflector for 2½-kw. MA. mercury vapour lamp.

the building, each half of the floor subtends a total angle in this plane of only 40 deg.

To light the floor evenly along the length of the building with as few units as possible, the light distribution in this direction should be wider and, as for conventional industrial reflectors, a "dispersive" type of distribution with a cutoff 20 deg. below the horizontal gives a reasonable compromise between the conflicting aims of long spacing and freedom from direct glare.

### The Lighting Unit

Fig. 3 illustrates the type of reflector that has been developed to meet these requirements, and its light distribution with a 2½-kw. MA. mercury vapour lamp is shown in Fig. 4. It will be seen that in the plane normal to the lamp axis high candlepowers are maintained up to approximately 20 deg. from the downward vertical, and there is a rapid fall off at higher angles. In the vertical plane containing the lamp axis the distribution is similar to a normal dispersive reflector.

The reflector efficiency may at first be considered low compared with conventional industrial reflectors, and this is mainly due to the large angle of collection and the

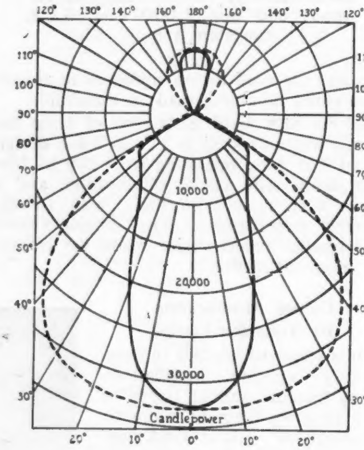



Fig. 4. Light distribution from reflector of Fig. 3. Dotted line—in plane containing axis of reflector. Continuous line—in plane perpendicular to axis of reflector.

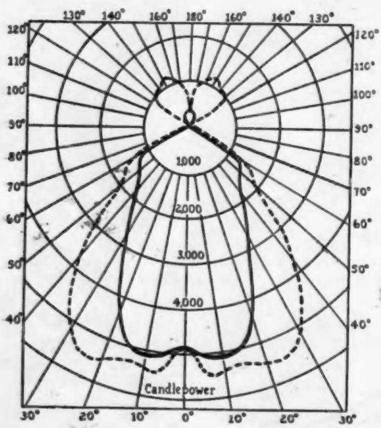



Fig. 5. Light distribution from high bay reflector with 1½-kw. G.L.S. tungsten lamp. Dotted line—in plane containing axis of reflector. Continuous line — in plane perpendicular to axis of reflector.

cage below the lamps. The former is necessary to produce the close light control which a narrow distribution demands, while the latter is a precaution against lamp breakage which may be modified or eliminated as operating experience is obtained.

Each lighting unit includes three similar reflectors, one for a 2½-kw. MA. mercury vapour lamp and two which can accommodate either a 1½-kw. G.L.S. tungsten or a 3-kw. line filament lamp, the latter having been used for experimental work on mercury/tungsten mixtures. The light distribution with a 1½-kw. lamp is shown in Fig. 5.

A later development will be a single reflector containing two 1½-kw. G.L.S. tungsten filament lamps, and this, with one reflector for a 2½-kw. MA. mercury lamp, will form the basic lighting unit. Two 1½-kw. tungsten

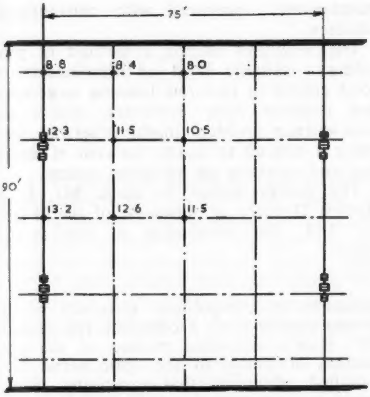



Fig. 6. Lighting layout with illumination values.

lamps will be used instead of one 3-kw. line filament lamp for practical reasons concerned with the supply and cost of the larger lamp.

### Lighting Layout

To obtain even illumination, the spacing of the units across the factory is somewhat critical due to their narrow distribution. Some reduction near the walls is inevitable with the symmetrical distributions employed, particularly as there are open side bays. In Fig. 6 the values of service illumination are shown for a number of places 2 ft. 9 in. above the floor with the lighting points indicated.

The spacing height ratio along the length of the factory has been made about 1½ : 1 in accordance with the normal practice using a dispersive distribution, the exact positions being fixed by the pitch of the roof girders.

Fig. 7 is a photograph of the unit on the special catwalks which have been built out from the side of the factory to accommodate the units and facilitate their servicing. The individual reflectors project light through rectangular apertures in the floor of each catwalk and can be inverted for cleaning and lamp replacement.

### Economics

While the potential advantages of a lighting unit containing these large lamps are mainly in the reduced number of points requiring maintenance, low costs of operating and repayment of the first charges may also be an important feature. In the course of considering the above method of providing the general lighting several alternative schemes using different types of lamps were designed, and their relative advantages may be stated as follows.

Tungsten filament lamps have the advantages of simplicity, an acceptable colour and the use of stock lighting fittings; to obtain the required illumination, however, many 1,000-w. industrial reflectors are needed, and the running cost is quite high due to the relatively low lamp efficiency.

Fluorescent lamps, while offering an ex-

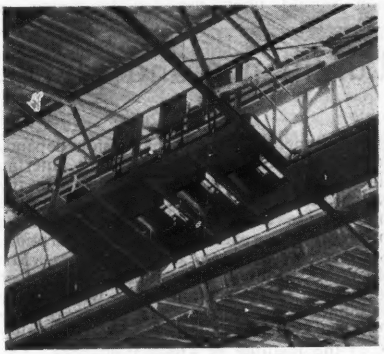


Fig. 7. Photograph of catwalks.

cellent colour and high efficiency, involve a very difficult maintenance problem and the replacement lamps are relatively expensive. The catwalks necessary to service them may also prove costly.

Mixed mercury and tungsten lamps in conventional industrial reflectors have some of the advantages of the 2½-kw. MA. system, but the larger number of units requiring installation and servicing result in an unfavourable balance.

All these schemes suffer from the disadvantage of a low coefficient of utilisation owing to the light distribution from the reflectors being similar in all vertical planes.

Combined mercury and tungsten fittings of the type shown in Fig. 1 approach the nearest to the system finally adopted, as the mercury section has a specular reflector with a narrow distribution in one vertical plane.

### Conclusions

A new type of lighting unit has been developed incorporating a high power mercury lamp and a reflector with light distribution characteristics suitable for high bays of relatively small width; a similar reflector for tungsten lamps will provide the required

colour modification with a high overall efficiency.

The mercury vapour lamp is of the MA. glass type, having a long life and operating directly in series with a choke from the 200-250-volt A.C. mains. It will run horizontally with a simple magnetic arc control consisting of a single inconel lead just above the lamp.

Estimates indicate that in addition to a reduction in first costs the fewer points requiring servicing in a large factory installation should offer considerable saving in maintenance, compared with conventional schemes.

The new unit affords a method of providing a suitable level of illumination of good colour in factories housing large-scale and possibly dirty processes, where the maintenance problem might otherwise well make it difficult to justify the cost of installing and servicing an adequate system.

The author wishes to thank Mr. L. J. Davies, Director of Research of the B.T.H. Co. Ltd., for permission to publish this paper.

## Luminance and Nerve Pulses

It is generally agreed that vision depends (a) on the absorption of the light entering the eye by photosensitive substances in the retina and (b) on the transmission along the optic nerve to the brain of nerve pulses produced as a result of this absorption. Starting from these two principles, Mr. R. W. G. Hunt has developed a theory of luminance discrimination, which he expounded at a recent meeting of the Physical Society's Colour Group (November 9, at the Institute of Ophthalmology). The theory is largely concerned with the smallest difference of luminance $\Delta B$ which can be detected, both when the eye is fully adapted to the actual field luminance B and when it has just previously been exposed to some different luminance $B^1$. According to measurements by Craik, the ratio $\Delta B/B$ is approximately constant for a considerable range of the luminances B and $B^1$. On Mr. Hunt's theory this result implies that N, the number of pulses per second being transmitted to the brain, must differ for the contrasted luminances by a constant fraction, i.e., the ratio $\Delta N/N$ must be constant. Mr. Hunt assumes that even when $\Delta B/B$ ceases to be constant—for example, when the luminance B is greatly reduced—the condition for discriminating the two luminances B and $B + \Delta B$ is still that $\Delta N/N$ has the same constant value. The observed variation of $\Delta B/B$ can then be used to make certain deductions about the way the pulse frequency N increases with the luminance B. From this and other evidence Mr. Hunt concludes that for scotopic or rod vision N increases as the cube root of B, while for photopic or cone vision the increase is much more rapid, as the first to the third power of B. The theory is also applied to explain the enhanced discrimination obtained by increasing the size of luminous patches being compared.

In the lively discussion which followed, criticisms by physiologist members of the Group ranged from a complete rejection of Mr. Hunt's simplified picture of the production of pulses in the optic nerve to a qualified admission that something like it might be assumed, but only for the early stages of the transmission process within the retina. On the other hand, Mr. Hunt was congratulated and encouraged by physicist members for a courageous attempt to link together photochemical and nerve pulse conceptions of the visual process and for the very clear way in which he had presented his ideas.

# Control of Fluorescent Lamps

## Elimination of control gear by use of tungsten ballast lamps.

On November 1, E.L.M.A. manufacturers announced a new development in connection with fluorescent lighting in which the usual choke and associated control gear are replaced by a tungsten filament lamp. Two types of circuits have been introduced for this purpose, but at present are applicable only to the control of 4-ft. 40-watt fluorescent lamps. The advantage of these circuits is that they give a considerable reduction in initial expenditure, weight and wiring are reduced and a power factor approaching unity is achieved.

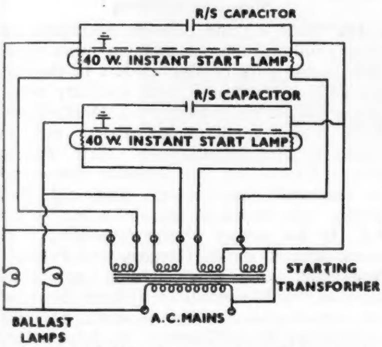



Fig. 1. B.T.H. instant start fluorescent lamp circuit with tungsten lamp ballasts.

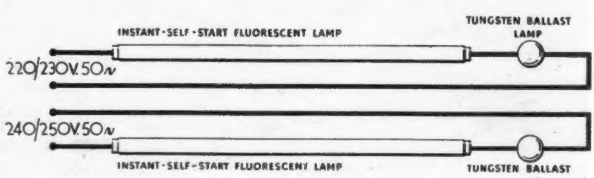
Fig. 1 shows one of the new circuits. In this case, for the sake of symmetry in the fitting and as one electrode heating transformer can be used for both fluorescent lamps, two filament and two fluorescent lamps are used. The fluorescent lamps are of the instant-start type with normal bi-pin caps. The tungsten ballast lamp is rated at 60-65 watts and has a life comparable with that of the fluorescent lamps in normal conditions. The overall consumption of such a fitting on 240 volts would be about 210 watts and the average light output using "Mellow" lamps would be about 4,000. The tungsten lamp has a three-pin B.C. cap to prevent its accidental use elsewhere.

Fig. 2 shows the alternative circuit which makes use of a special fluorescent lamp which has single contact caps and an internal starting strip. This latter performs the same function as the auxiliary starting electrode in the ordinary mercury lamp. The tungsten lamp has a three-pin B.C. cap.

Both of these systems give instant starting and an average luminous efficiency throughout life of about 20-22 lumens per watt depending on the colour of the fluorescent lamp used. The light output from the tungsten lamps is made full use of and the blend of tungsten and fluorescent can produce a pleasing effect.

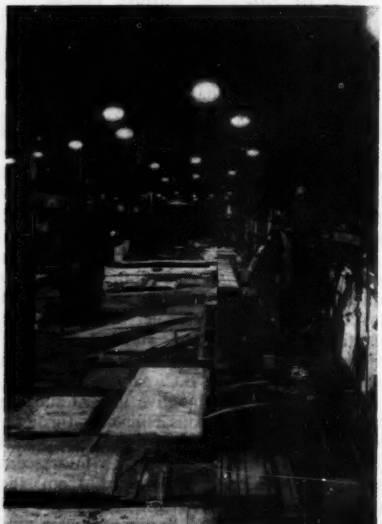
The fitting designed by the G.E.C. for using this new circuit directs the light from the tungsten ballast lamps in an upward direction. Philips Electrical have developed an initial range of four new fittings for commercial, domestic and industrial lighting in which the two tungsten lamps in the circuit are fitted one each end of the fitting to throw their light in the downward direction. The lower half of the tungsten lamps used in these latter fittings is silvered to direct the light up to a reflector which then directs all the light output of the tungsten lamp into the downward direction.

Fig. 2. Philips' instant self-start circuit.



# New Lighting Installations

- **Shipyard Lighting**
- **A Bookstall**
- **An Assembly Shop**
- **An Engine Shop**



### Shipyard Lighting

The modern trend towards prefabrication in shipbuilding has necessitated more attention on the part of shipbuilders to the layout and equipment in their ancillary workshops. Recently, Messrs. Wm. Doxford and Sons, Ltd., Sunderland, carried out an extensive reorganisation of their Pallion Shipyard involving the complete renewal of its electrical installation. The old D.C. system was replaced by 415-volt 3-phase A.C. to the design of the consulting engineers, Messrs. R. W. Gregory and Partners, Newcastle, and new lighting equipment supplied by Metropolitan-Vickers Electrical Co. was installed. The workshops, which cover more than 57,000 sq. ft., have a new

*(Above).* Showing the lighting in the Platers' Shed using 750 watt tungsten lamps at 30 ft.

*(Left).* The Mould Loft lit by 500 watt lamps at 14 ft.

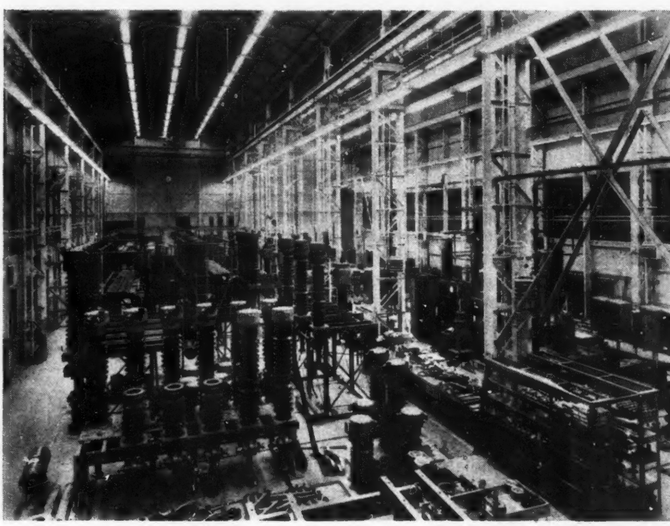

The newly designed W. H. Smith bookstall lighted inside by 2 and 3 ft. fluorescent lamps.

and up-to-date lighting installation which was completely installed during the annual shut-down period of 10 days.

The new overage illumination values in lm./ft.$^2$ for the various shops are: New Joiners' Shop, 15; Tinsmith Shop, 10/12; Platers' Shed, 8/9; Joiners' Shop, 15; Plumbers' Shop, 10/12; Mould Loft, 16/18.

**A Bookstall**

The lamps and equipment for the lighting of the newly designed W. H. Smith Bookstall at Fenchurch Street Station was supplied by Siemens Electric Lamps and Supplies, Ltd. The advertising panels and the magazine rack are lit by a false "Perspex" cornice with a louvred base.



Lighting by cold cathode lamps in the new E.H.T. switchgear assembly shop at the Hebburn works of Messrs. A. Reyrolle and Co. Ltd.

High bay lighting by 1,500 watt units mounted at 74 ft. in the engine shop of a shipbuilding and engineering works.

**An Assembly Shop**

The lighting installation of the new E.H.T. switchgear assembly shop at the Hebburn works of Messrs. A. Reyrolle and Co., Ltd., has been planned, installed and erected by that company's own electrical engineering department, working in close contact with the illuminating engineering department of the General Electric Co., Ltd. The installation comprises 180 G.E.C. industrial-type triple-tube cold cathode units.

In each of the two bays of the shop there are five rows of 18 fittings, mounted end to end. Six of the 10 rows of units are at a height of some 40 ft. so as to be above crane level. The four remaining rows (one along each outside wall and two in the centre) are mounted well clear of the underside of the crane at a height of some 25 ft. above ground.

The average illumination at an optimum working plane 4 ft. above the ground level was found to be 25 lumens per sq. ft. after the installation had been in use for several hundred hours. At the fitters' benches, below the two central rows of fittings, the level of illumination was 30 lumens per sq. ft. With the new lighting it is found unnecessary to use handlamps for inspecting the interior of castings and for similar purposes, all portions of the gear under assembly being adequately illuminated.

**An Engine Shop**

The centre bay of the engine shop in the shipbuilding and engineering works of Messrs. Cammell Laird and Co., Ltd., Birkenhead, has recently been equipped with a lighting installation of three rows of Benjamin 1,500-watt high bay units mounted at 74 ft. above floor level. The north and south bays in this engine shop utilise 1,000-watt high bay units mounted at 49 ft., the average overall illumination being 10 lm./ft.$^2$. The total load in the three bays is 236 kw.

Each unit is fitted with a heavy duty "Saaflux" top and with a clear-glass visor cover rendering it dustproof. The reflector is made of aluminium providing a semi-specular reflecting surface in order to direct the light in a concentrating type of distribution and at the same time avoiding striation. The outside is sprayed aluminium.

This engine shop, in which engines for the smallest vessels to that of the recently launched Ark Royal have been produced, is believed to be the largest of its kind in the shipbuilding industry.

The maintenance of the fittings is all carried out from the overhead electric travelling cranes which serve each of the bays.

The electrical installation was carried out by the Cammell Laird Works electrical department.

# I.E.S. ACTIVITIES

### Annual Dinner in London

It is announced that the Annual Dinner/Dance this year will be held at the Cafe Royal, Regent-street, London, on Wednesday, May 9, i.e., the day following the Annual General Meeting.

Members from the provinces who will be attending and who will require accommodation for the night in London are advised to make arrangements without delay. The Festival of Britain will be opening at about that time and it is anticipated that it will be extremely difficult to obtain hotel accommodation in London next summer.

Tickets for the Dinner/Dance will be 30s. each. It is hoped that as many I.E.S. members as possible, both from London and the provinces, will support this function.

### Visit to the New House of Commons

Permission for the Society to visit the new Chamber and plant rooms at the House of Commons has kindly been given by the Lord Great Chamberlain. The visit will take place on Friday, January 26. Members will be taken round in two parties, each of which is limited to a maximum of 25; the first party will be admitted at 4 p.m. and the second party at 4.30 p.m. Admission will be by ticket only, which may be obtained from the I.E.S. Secretary, 32, Victoria-street, London, S.W.1.

### Presentation to Ward Harrison

A feature of the opening session of the I.E.S. North-eastern Regional Conference of the American I.E.S. in October was the presentation to Dr. Ward Harrison of the certificate of Honorary Membership of the British I.E.S., which, it will be recalled, the council awarded to him some months ago. The presentation was made by the president of the Society, Mr. L. J. Davies, who was paying a visit to the U.S.A. at that time.

In making the presentation of the highest honour which can be awarded by the Society, Mr. Davies stated that no other American had been so honoured. Mr. Davies also read the citation which states that the award had been made to Dr. Harrison "in acknowledgment of his numerous and valuable contributions to the advancement of the art and science of lighting and in recognition of the eminence he has attained thereby."

Dr. Harrison received the American I.E.S. Gold Medal in 1949; he is also a Fellow of the American I.E.S. and its eighteenth president. He was the first to receive the honorary degree of Doctor of Illuminating Engineering awarded to him in 1940 by the Case School of Applied Science. For nearly two decades he was director of engineering in the lamp department of the General Electric Company of America.

Dr. Ward Harrison receiving the certificate of Honorary Membership of the British I.E.S. from Mr. L. J. Davies, President of the Society.

**London**

At the London meeting on December 12 Dr. B. P. Dudding, of the research laboratories of the General Electric Co., Ltd., gave a lecture entitled "The Development of the Tungsten Lamp." The lecture began with a brief survey of the conditions prevailing in the lighting industry when the tungsten lamp was introduced early in the present century and it was shown how these conditions had influenced subsequent technical and production developments.

The scientific principles and investigations which have inspired and influenced improvements in the manufacture and performance of the lamp were reviewed and illustrated by demonstrations. The various aspects of the development of the lamp which were dealt with included the metallurgy of the necessary special metal and glass components, the physical and chemical problems associated with the exhaust and gas filling operations, the engineering problems associated with the lamp assembly, and the production problems associated with the economic utilisation of materials and the maintenance of a uniform high standard of lamp performance.

Dr. Dudding also showed how closely progress in the technical and production fields have been interwoven and how workers in each of these fields have been stimulated by day to day contact with colleagues in other fields.

**Birmingham Centre**

The Birmingham Centre held its second Sessional Meeting on Thursday, November 2. The chairman, Mr. F. Penson, presided and the meeting took the form of a demonstration and display of new lighting equipment. This demonstration is a biennial event and only equipment developed in the previous two years is accepted. It is very popular and on this occasion many people found "standing room only."

The competition for places is keen and lots had to be drawn to select the 12 exhibitors, which is the maximum number that could be accommodated in the showroom where the display was held. The representatives at the various stands were allowed four minutes in which to describe the maximum number of four fittings.

Among the various interesting items on show were a large number of fluorescent fittings including one or two using the new 4-ft. fluorescent lamp with a series ballast tungsten lamp. There were several class "B" street lighting units for both tungsten and 2-ft. fluorescent lamps. A high bay unit was to be seen, using the new 1,000-watt mercury vapour discharge lamp, and vapour proof fittings of various types. There were also on show floodlights and spotlights, prismatic glass fittings of various kinds and a new motor headlamp lens.

After all the fittings had been described there was a short discussion followed by a vote of thanks proposed by Mr. Addenbrooke of the Midland Electricity Board on behalf of the visitors. He expressed a deep appreciation of the opportunity of seeing what was new in the lighting world. This concluded the meeting and gave everyone present a chance to get more closely acquainted with the exhibits on the stands.

At a Sessional Meeting of the Birmingham Centre, held on December 1, 1950, Mr. R. O. Ackerley presented his paper on Floodlighting. There was a particularly good attendance; a compliment to Mr. Ackerley's usual forthright presentation of good material. It was quite a topical occasion as the paper was issued in the I.E.S. Transactions on the same day.

During the discussion which followed, Mr. Cox, a well-known local architect, remarked that the floodlighting of Gothic architecture was particularly successful, probably owing to the modelling and detail. Floodlighting also succeeded when prominent vertical members were present, and he viewed with approval the method of floodlighting buildings from a long distance with a single high-powered sources. It seemed to him that the shadows looked more natural than most floodlighting with its almost universal upward lighting.

Mr. P. Hartill wanted to know whether there were any figures showing a comparison of values of illumination required when coloured lighting was used as opposed to white lighting, and taking into account the extra emphasis obtained with colour. Mr. Alderidge offered an easy solution of the problem of lighting a clock face when the exterior was floodlighted. The solution was to change the interior lighting over to M.V. Discharge, thus obtaining a colour and brightness contrast, without increasing the wattage.

Mr. Ackerley, in replying to the discussion, stated that reverse shadows and their effect often compensate for the loss of "rightness" usually seen by natural light. His main concern was not—Does it look right? but Does it look beautiful? Answering other remarks, Mr. Ackerley said that tungsten lamps were most easily controlled, mercury vapour lamps should be used for emphasis, and that fluorescent lamps had very little value for floodlighting, and should be used

for supplementary lighting. Colour, he said, should be used with discretion; there were no comparison figures for colour as opposed to white floodlighting.

Mr. Lovell, in proposing a vote of thanks, referred to the popularity of Mr. Ackerley as a lecturer, and Mr. Gibbs seconded the vote.

### Leeds Centre

The annual social evening of the Leeds Centre was held at the Guildford Hotel, Leeds, on Friday, October 6, 1950, when the centre welcomed as their chief guest the President of the Society, Mr. L. J. Davies. Other guests included many distinguished members of kindred societies in the Leeds area.

In proposing the toast to the Illuminating Engineering Society, Dr. E. C. Walton, representing the Institution of Electrical Engineers, pointed out that, although he was attending as a guest, he was also a member of the Illuminating Engineering Society. Dr. Walton dwelt on the question of education and the illuminating engineer, and congratulated the students who were present who had completed the Inter. and Final Grade Courses in Illuminating Engineering.

In reply, the President, Mr. L. J. Davies, said he was pleased to take this opportunity of visiting Leeds and meeting members of the Leeds Centre. Mr. Davies very briefly talked of technological advances in the lighting field and stressed the fact that every individual in the industry had an important function to perform if progress was to be made.

The toast to the Leeds Centre was proposed by the immediate past chairman, Mr. A. G. Smith. Mr. Smith said the Colour Matching Exhibition which had been partially organised by the Leeds Centre might be remembered for some time to come, due to the valuable information which had been obtained and recorded. The new chairman of the Centre, Mr. J. W. Howell, replied.

## Forthcoming I.E.S. Meetings

### LONDON

**January 9th**
Sessional Meeting. "Brightness Engineering," by W. Robinson. (At the Lighting Service Bureau, 2, Savoy Hill, W.C.2.) 6 p.m.

**January 17th**
First Trotter-Paterson Memorial Lecture. "The Early Years of Illuminating Engineering in Great Britain," by J. W. T. Walsh. (At the Royal Institution, Albemarle Street, W.1.) 6 p.m.

### CENTRES AND GROUPS

**January 3rd**
"Design of School Lighting," by J. F. Roper. (At the Minor Durrant Hall, Oxford Street, Newcastle-on-Tyne, 1.) 6.15 p.m.

**January 3rd**
"Lighting of Departmental Stores," by A. W. Jervis. (At 4, Northampton Gardens, Swansea.) 5.45 p.m.

**January 4th**
"Lighting of Departmental Stores," by A. W. Jervis. (At the South Wales Electricity Board, Demonstration Theatre, The Hayes, Cardiff.) 5.45 p.m.

**January 4th**
"Floodlighting," by R. S. Hazell. (At the Agricultural House, Queen Street, Exeter.) 7 p.m.

**January 5th**
"Floodlighting," by R. S. Hazell. (At the South Western Electricity Board Showrooms, Bath.) 7 p.m.

**January 5th**
"Commercial Lighting of Big Stores and Shops," by L. E. Gibbs. (At the Imperial Hotel, Temple Street, Birmingham.) 6 p.m.

**January 5th**
"Lighting for High Speed Photography," by J. Hadland. (At the Electricity Showrooms, Market Street, Huddersfield.) 7.15 p.m.

**January 8th**
"Home Lighting," by Miss M. Wardlaw. (Joint meeting with the Electrical Association for Women.) (At the Lighting Service Bureau, 24, Aire Street, Leeds, 1.) 7 p.m.

**January 10th**
"Art and Science of Lighting in the Home," by Miss M. Wardlaw. (At the Welfare Club Hall of the City of Edinburgh Lighting and Cleansing Department, High Street, Edinburgh.) 7 p.m.

**January 10th**
Annual Dinner. (At the County Hotel, Neville Street, Newcastle.) 7 p.m.

**January 11th**
"Lighting in the Home," by Miss M. Wardlaw. (At the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.) 6 p.m.

**January 11th**
"Acrylic Plastics on Lighting," by P. H. Collins. (At the Demonstration Theatre, East Midlands Electricity Board, Leicester Sub-Area, Charles Street, Leicester.) 6.30 p.m.

**January 11th**
"The Contractor Sheds Some Light," by F. Aincow. (Joint Meeting with the Electrical Contractors Association.) (At the Demonstration Theatre, Manchester Town Hall Extension.) 6 p.m.

**January 12th**
Annual Dinner. (At the Imperial Hotel, Temple Street, Birmingham.) 6 p.m.

**January 16th**
"Light, Colour and the Stage," by E. Faraday. (At the Lecture Theatre, Merseyside and North Wales Electricity Board's Service Centre, Whitechapel, Liverpool, 1.) 6 p.m.

**January 17th**
"Decorative Lighting," by L. H. Hubble. (At the Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough.)

**January 18th**
"Lighting of Architecture," by G. Grenfell Baines. At the Cadena Cafe, High Street, Cheltenham.) 6.30 p.m.

**January 25th**
"Textile Lighting," by T. S. Jones. (At the Gas Showrooms, Parliament Street, Nottingham.) 5.30 p.m.

**January 25th**
"Light, Colour and the Stage," by E. Faraday. (At the Yorkshire Electricity Board, 45/53, Sunbridge Road, Bradford.) 7.30 p.m.

**January 31st**
Presidential Address, by L. J. Davies. (At 4, Northampton Gardens, Swansea.) 5.45 p.m.

# POSTSCRIPT

## By "Lumeritas"

Wars and rumours of wars seem to be with us always, and a quaint reminder of an old war recently appeared in a popular weekly magazine which interested me by its reference to sight. It appears that in the eighteenth century, when we were at war with the French, the Postmaster-General introduced a scale of compensation for those who were injured by the enemy while carrying our mail overseas. Loss of the sight of one eye was valued at £4 per annum, and that of the pupil of the eye at £5. Compensation for loss of the sight of both eyes was £12, and for the loss of the pupils of both eyes £20. One wonders what is meant by loss of the pupil, and how this loss could have been deemed a greater disaster than loss of the sight of the eyes.

Looking through my December number of this journal, I was surprised to read that the architecture and decoration of the new Chamber of the House of Commons have been planned "with less profusion of armament than its predecessor." Doubtless many wordy battles will be fought in the new Chamber. Perhaps, however, it was no thought of these, but rather the reiteration of the word in the news we have been getting lately that "conditioned" the compositor to read "armament" for "ornament"!

Apropos the new Chamber, a critical letter recently appeared in the weekly Press over the signature of one who claims to speak with authority by reason of having served a seven years' apprenticeship with an eminent London building firm. The writer of this letter evidently is not a reader of LIGHT AND LIGHTING or he would be better informed than his letter shows him to be. His "principal objection is to the oriel skylight. The only position for oriel stonework is vertical, not horizontal. Above one's head it is bad artistically and top-heavy in appearance. The dictionary definition of oriel is: 'A window resting on corbels.' This window admits too much light in the wrong place. It will have a deleterious effect on the countenances of Members. If a bomb should drop anywhere near the House the heavy stone and glass skylight would collapse and there would be very few legislators left to tell the tale." Well, well! The "skylight" is a laylight and, although it is divided into bays, I doubt if architects would call it an oriel window merely on this account. The "stonework" and "heavy stone" is actually carved oak, and one gathers from Members that any deleterious effect of the light on their countenances is due to its spectral quality rather than to its quantity.

Power cuts have also prompted letters to the Press recently. One correspondent complains that, apart from the inconvenience they cause, unannounced cuts are dangerous and can lead to serious accidents in the home and elsewhere. He suggests that warning of an impending cut might be given by flickering the supply for half a minute before the cut is made. Unfortunately, such a method of warning would be damaging to generating plant and factory machinery, and the flickering of lights might be hardly less dangerous than their abrupt extinction.

Sir John Parsons has drawn my attention to the difficulty experienced by railway passengers in discerning the names of stations from the train in which they are travelling. On a journey from Birmingham to Leeds recently he found all the signs which were visible—and they were not many—were illegible to him. They consisted of white letters on a palish red background and the letters were too small. Surely, Sir John suggests, there should be some improvement and uniformity before the Festival of Britain. I do not think there is any doubt that improvement is necessary. Regional colour schemes should not be applied to station name signs unless the contrast afforded between letters and background is excellent by natural as well as by artificial light. I have seen some very good internally illuminated station name signs, but many more which are very poorly lighted. Road traffic signs are placed "broadside on" to approaching vehicles, but station name signs are arranged parallel to the railway track, and on this account alone they are not easy to decipher as a train is running in and out of a station. Would it not be an improvement if large name signs were erected transversely or obliquely at each end of the platform?

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